This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

THE

STUDENT'S GUIDE

TO THE

PRACTICE OF DESIGNING, MEASURING, AND VALUING

ARTIFICERS' WORKS.

SECOND EDITION.

LONDON:
PRINTED BY C. F. HODGSON,
GOUGH SQUARE, FLEET STREET.

THE

STUDENT'S GUIDE

TO THE

PRACTICE OF DESIGNING, MEASURING, AND VALUING

ARTIFICERS' WORKS;

CONTAINING,

DIRECTIONS FOR TAKING DIMENSIONS,

ABSTRACTING THE SAME,

AND

BRINGING THE QUANTITIES INTO BILL;

WITH

TABLES OF CONSTANTS,

AND COPIOUS MEMORANDA FOR THE VALUATION OF LABOUR AND MATERIALS IN THE RESPECTIVE TRADES OF BRICKLAYER AND SLATER, CARPENTER AND JOINER, SAWYER, STONE-MASON, PLASTERER, SMITH AND IRONMONGER, PLUMBER, PAINTER AND GLAZIER, PAPER-HANGER.

THIRTY-EIGHT PLATES AND WOODCUTS.

THE MEASURING, &c. EDITED BY

EDWARD DOBSON, ARCHITECT AND SURVEYOR.

Second Edition,

WITH THE ADDITIONS ON DESIGN BY

BY E. LACY GARBETT, ARCHITECT,

AUTHOR OF "RUDIMENTARY TREATISE ON THE PRINCIPLES OF DESIGN IN ARCHITECTURE," IN TWO VOLS.

LONDON:

JOHN WEALE, 59 HIGH HOLBORN.

1852—1853.

173. e. 14.

ERRATA.

Page 26, end of note . . .
—— 46, line 10. . . . .
—— 81, — 12 of note . .
—— 116, end of paragraph . } *for* "ornament" *read* "decoration."

—— 41, last line but 10 . . *for* "thus" *read* "this."
—— 56, line 15 . . . . *for* "move" *read* "made."
—— 80, — 14 . . . . *for* "*aa*, between skewbacks" *read* "between skewbacks *aa*."

PRELIMINARY REMARKS

ON THE

DESIGN OF ARTIFICERS' WORKS.

In the absence of Mr. Dobson, I have been desired to add, in a Second Edition of this justly valued collection, such further memoranda as seemed most needed at present. Though the professions of designing and measuring artificers' works would be best entirely separated, they are now so often united, that the most useful addition I could make, seemed a brief account of the present practice of designing the works of each trade, with a view to its improvement; assuming, as I have, that while our measuring and valuing is at present well done, the same cannot honestly be said of our designing—that people in general have no great satisfaction therein; and that we who practise it, desire not only to get our pay, but (what is much harder) to deserve it.

In the design of building-works, two excellences are attempted or supposed, right structure, and right decoration. The former includes not merely the complete answering of the material ends, or what engineers now reduce it to, but far more, viz., the answering them without cobbling or unforeseen alterations and additions; and further still, the answering them economically (in the original sense of the word) and nobly, *i. e.*

without waste of means, and without using any manual labour whatever to save thought. The last condition, I shall shew, excludes at once all recent engineering. On the other points we cannot attain perfection, as the brutes do, because we have not, like them, a perfect Designer. Observe, then, that without the second kind of excellence, the decorative, our works would be *inferior* to beaver-nests; whence we may infer that decoration (gracing, *decor* = grace) is necessary in all our work; and in fact it is (or something intended for it, is) found as universally in human as in Divine work. It is that which assimilates man's work to God's, and distinguishes it from the brutes'; so that he might be defined (has been, for aught I know,) as a *decorating* animal. All human work must have decoration, but all need not have *ornament*. By ornament is properly meant something extraneous to the work, added for the sake of beauty; some *thing* added, observe, while decoration is only some *work* added. Thus decoration includes all ornament, but there is plenty of true decoration which is not ornament. That only is ornament which involves either the adding of unnecessary matter (as an ancient statue or finial, a modern tower or portico), or the leaving matter that would, with less labour and equal structural efficiency, have been removed (as a crocket, a bas-relief figure). To confound, therefore, (as an excellent critic has done,) the terms beauty, decoration, and ornament, is as new and perplexing as if we should confound blackness, blackening, and blacking. Blacking is something added to give blackness; ornament, something added to give beauty. Again, blackening is work bestowed to produce blackness, which may be done without blacking; and decoration is work bestowed to produce beauty, which may be done without ornament—*ought* to be done without it sometimes,—in prison and workhouse-building times, for instance. There is a time to scatter stones, and a time to gather them, and husband even bricks; a time to plate the temple doors with pure gold, and a time to cut it down for tribute (though none for replacing it with tinsel); a time for the lamp of "sacrifice of things costly, because they are costly," and a time to learn what that means, "I will have mercy, and not

sacrifice;" and he that pretended to want Mary's ointment sold was blamed, not for the proposal, but for the wrong time of it. Time and place make vast differences. Ornament has no becoming place on the work of debtors or beggars, though decoration has; at least such as involves not extra handiwork, but only extra brainwork, which is quite possible.

Now, there can be only one chief artificer, or architect, at one time, to one work. Therefore the structural and the decorative excellence must both come through one mind. No division of labour can come to divide these two, engineering and decoration, without destroying both. You may have men called engineers, and men called decorators, but neither *real* engineering nor *real* decoration (of building) can you ever have, except the same man profess *both*. For, observe, a pile of useful undecorated things, covered with beautiful useless things, is neither right building nor right beautifying. It is right in no sense, for it is not human,—it is no more than a beaver and a monkey could make between them out of old clothes. To be a work of art—to be worthy of humanity—not only must the whole, but also every member, every detail (except ornaments), be a piece of decorated utility. So that every the smallest part (except ornaments) must be designed by some one who is engineer and decorator at once.

But though both engineering and decoration must influence the design of every right detail, it is plain that every single question which can arise, whether of the whole or of a detail, must be treated either as an engineering or a decorative question. It cannot be answered on both grounds; for if the architect say, for instance, This line would, as a matter of physical use, be best *so*, but taste requires it rather to be *so*, he must decide one way or the other. Nothing, therefore, is more important than a rule to know which is the right ground of decision in every case,—what questions we are to answer as engineers, and what as decorators. I cannot find that architects have any such rule. I cannot find a single question which is not sometimes made matter of use, sometimes of taste, to the great inconvenience and expense of the public.

Now, in the most admired, even in the most decorated, buildings of past ages, such a rule appears; and it is impossible to conceive a simpler one. It is, that *whatever* point might be decided by utility, *was* so decided. No matter how narrow or how wide the limits to which a form might be determined by engineering considerations, within these limits alone was taste allowed to vary it. Æsthetics settled nothing which could be settled anyhow else. In no one particular was a thing made, for taste's sake, less efficient than it might have been. Such is Grecian, such mediœval architecture: and as I am not prepared to reject the whole of these as wrong, from beginning to end, I have no alternative but to reject the Roman and modern; for two opposite right ways there cannot be.

The modern so called "architects," while making the leaves of a capital matter of unalterable rule, have made every conceivable question that was determinable by engineering—from the plan of a church, or the placing of its organ, to the shape of a tile—matters of unlimited fancy, or of ever-changing fashion, or "taste." Now, what can good taste mean, if it do not mean God's taste? Has He so made the laws of matter, that whatever is physically best for us, is in bad taste? Yes, answers every modern building; and our architects have endeavoured to reconcile the discrepancy, to strike the balance, and take the happiest mean between His laws and His taste. Well, I can only say I do not think they have succeeded, nor the tailors either. But let the reader be assured of this, that however unaccountable anything may seem, either in modern architecture or modern tailoring, it has not been done without a reason—one reason, and that one the same in both.

I have said little of decoration in this work, because the reader can be referred to Mr. Ruskin's two chapters entitled "Material" and "Treatment of Ornament" (properly, of *decoration*), which I consider far the most valuable essay on this matter ever written.

E. LACY GARBETT.

July 3, 1852.

ADVERTISEMENT TO THE FIRST EDITION.

THE following Work was originally written expressly for the rising student, by an eminent Architect and Surveyor of upwards of fifty years' experience; but the manuscript having been left at his recent death in an imperfect state, it has been carefully arranged for publication, with much additional matter, by Mr. EDWARD DOBSON, who was educated in the office of an active measuriug surveyor, and who is the author of "A Statistical Account of the Railways of Belgium," to whom I am also indebted for the correction of the proofs.

It is anticipated that this volume will fill the wide space between the student and the practical man, by removing the perplexing difficulties which hitherto have been a barrier to his advancement, and which can be appreciated only by those who aspire to be correct and efficient men of business in the profession they may desire to follow.

JOHN WEALE.

May 23, 1843.

ADVERTISEMENT TO THE SECOND EDITION.

THE First Edition of this work having for some time been out of print, and Mr. Dobson having left England, to superintend works and employ his talents in New Zealand, I have sought the aid of Mr. EDWARD LACY GARBETT, Architect, to add his comprehensive knowledge of practical architecture to this Edition, whose name will be a sufficient guarantee both for the student and the practical man.

JOHN WEALE.

July 3, 1852.

CONTENTS.

page

PRELIMINARY OBSERVATIONS ON DESIGNING ARTIFICERS' WORKS.... v
Preliminary Observations on Measurement, Valuation, &c. 1
On measuring 6
On rotation therein 8
On abstracting quantities 9
On valuation 10
On the use of constants of labour 11

BRICKLAYER AND SLATER.

DESIGN OF BRICKWORK,—technical terms, &c. 15
Foundations 19
Arches, inverted and erect 21
Window and other aperture heads 25
Window jambs 31
Plates and internal cornices 35
String courses 36
External cornices 37
Chimney shafts 38
On general improvement of brick architecture, especially fenestration 41
MEASUREMENT, of diggers' work 47
Of brickwork, of facings, &c. 50
DESIGN OF TILING, and technical terms 53
Measurement of tiling 56
Example of the mode of keeping the measuring-book for brickwork. 58
ABSTRACTING Bricklayers' and Tilers' work 61
Example of bill of bricklayers' and tilers' work 64
VALUATION of Bricklayers' work, Earthwork, Concrete, &c. 65
Table of sizes and weights of various articles 67
Tables of the numbers of bricks or tiles in various works 67
Valuation of diggers' and bricklayers' labour 69

page
Table of Constants for said labour 70
EXAMPLES OF VALUING,—1, A yard of concrete 71
2, A rod of brickwork;—3, A foot of facing 72
4, A yard of paving;—5, A square of tiling 73
DESIGN AND MEASUREMENT OF SLATING 73
Valuation of slating 75

CARPENTER AND JOINER.

DESIGN OF CARPENTRY,—technical terms, &c. 77
Breast-summers, an abuse. Substitutes for them 79
Joists, Trimmers, Trimming-joists 81
Girders, their abuse and right use 82
Substitutes for girders and quarter-partitions 86
Quarter-partitions 87
Roof-framing 89
Great waste in present common modes of roof-framing 1
To determine the right mode of subdividing the weight 95
And the right numbers of bearers for leaded roofs 98
The same for other roofs 99
Principle of the truss 101
Considerations that determine its right pitch 102
Internal filling or *tracery* of trusses 105
Collar-beam trusses 109
Connection of the parts of trusses 110
Variations on the truss,—right limits thereto 112
To avoid fallacious trussing and roof-framing 113
Delorme's roofing, its economy on circular plans 115
Useful property of regular polygonal plans 116
On combinations of roofing, hips, and valleys 117
On gutters, their use and abuse 118
Mansarde or curb roofs 120
DESIGN OF JOINERY, technical terms, &c. 121
Modes of finishing and decorating panel-work 122
Design of doors 124
MEASUREMENT of Carpenters' and Joiners' work,—Abbreviations 126
Modes of measuring Carpenters' work 128
Classification of labour when measured with the timber 128
———— of labour and nails when measured separately from the timber 129
EXAMPLES OF MEASUREMENT, arch centerings 132
Bracketing to sham entablatures, gutters 133

page
Sound-boarding, chimney-grounds, sham plinths 134
Sham pilasters, floor-boarding, mouldings 135
Doorcases, doors, doorway linings 136
Dado or surbase, its best construction..... 137
Sashes and sash-frames (examples of measurement) 138
Shutters, boxings, and other window fittings 139
Staircases and their fittings 140
ABSTRACTING Carpenters' and Joiners' work 142
Example of Bill of Carpenters' and Joiners' work..... 146
VALUATION of Carpenters' and Joiners' work, Memoranda 148
Tables of numbers and weights 149
TABLES OF CONSTANTS OF LABOUR, roofs, naked floors 150
Quarter-partitions, Labour on fir, per foot cube 151
Example of the valuation of deals or battens 152
Constants of labour on deals, per foot superficial 153
CONSTANTS OF LABOUR and of nails, separately, on battening, weather boarding 153
Rough boarding, deal floors, batten floors 154
LABOUR AND NAILS together, on grounds, skirtings, gutters, doorway linings 155
Doors, framed partitions, mouldings 156
Window fittings 157
Shutters, sashes and frames, staircases 158
Staircase fittings, wall-strings 159
Dados, sham columns and pilasters 160
VALUATION OF SAWYERS' WORK 160

MASON.

DESIGN OF STONE-MASONS' WORK 162
Dr. Robison on Greek and Gothic architecture 163
Great fallacy in the Gothic ornamentation 166
Which led also to the modern "monkey styles" 167
"Restoration" and Preservation 170
MEASUREMENT of Stone-masons' work 175
Example of measuring a spandril step, three methods 177
Allowance for labour not seen in finished stone 180
Abbreviations, Specimen of the measuring-book 181
Stairs, Landings, Steps, Coping 183
String-courses, Plinths, Window-sills, Curbs 185
Columns, Entablatures, Blockings 187

page
Cornices, Renaissance Niches 189
ABSTRACTING AND VALUATION.—Table of weight of stone 190
Table of Constants of Labour 191
Example of Bill of Mason's work 193

PLASTERER.

DESIGN OF PLASTER-WORK in real and mock architecture 194
Ceilings and their uses 197
Unnecessary disease and death traced to their misconstruction..... 198
Sanitary requirements for a right ceiling..... 202
Conditions to be observed to render domestic ceilings innoxious.... 206
Ditto, for ceilings of public buildings 211
Barbarous shifts necessitated by wrong ceiling 213
Technical terms in Plasterers' work..... 214
MEASUREMENT of Plaster-work, Abbreviations 216
Abstracting of Plasterers' work 219
Example of Bill of Plasterers' work 220
VALUATION.—Memoranda of quantities of materials 220
Constants of Labour 221

SMITH AND FOUNDER.

ON THE USE OF METAL-WORK IN ARCHITECTURE 222
Iron not rightly to be used much more now than in the middle ages 225
Substitutes for the present extravagant use of iron 227
Fireproof (and sanitary) ceiling and flooring 229
Fireproof roof-framing in brick and iron..... 232
Another method, applicable to hipped roofs 236
A mode of untrussed roof-framing in iron only 238
A principle for iron trussed roofing on any plan or scale 239
Another variation thereof 240
On the decoration of metallic architecture 241
MEASUREMENT of Smiths' and Founders' work 242

PLUMBER, PAINTER, GLAZIER, &c.

DESIGN, &c. OF LEAD-WORK 247
MEASUREMENT OF PAINT-WORK, Abbreviations 249
Specimen of the measuring-book 250

page
Abstract of Paint-work 251
Example of Bill of Paint-work 252
VALUATION of Paint-work.—Constants of Labour 253
Measurement and Valuation of GLAZING 254
Measurement and Valuation of PAPER-HANGING 255

APPENDIX ON WARMING.

Modifications of sanitary construction to suit the English open fire..... 257
More economic modes of warming in public buildings 257
Ditto, for private ones 260
Warming by gas..... 266

THE PRACTICE

OF

MEASURING AND VALUING

ARTIFICERS' WORK.

PRELIMINARY OBSERVATIONS.

THE Author, having retired from the profession, has been enabled to devote considerable time to the preparation of the present work, which is intended for the information of the young student, in a department which, in some respects, is not the most pleasant part of the architect's duty; more particularly when it is one to which he does not feel himself perfectly competent, which is the case if he has not had the opportunity, or has neglected to avail himself of the means, of obtaining the requisite information. It is therefore strongly recommended to the student, that, after he has acquired sufficient knowledge of construction for making out working drawings correctly, he should attend to the rules by which, in due time, he may become qualified to measure and value the work when performed. The disinclination often felt by young

gentlemen of education for the study of these rules, and of the mechanical part of the profession, make it the more necessary to impress on their minds the absolute necessity of studying these essential qualifications,—which can only be done with any probability of success, by commencing at the lowest, and rising gradually to the higher departments. If the student neglects the operative part, he must never expect to be capable of making working drawings without incurring the ridicule of the mechanic; and when he commences business on his own account, if he also neglects the measuring department, he will be obliged to employ persons to make out his specifications, and to measure and value his works when completed. The expense incurred by thus employing others to do what he is incapable of, is a minor consideration; for it is imperative on the young architect to reflect that he will be the responsible agent between the gentleman and the builder, and that if, during the erection of an edifice, he allows the work to be insecurely performed, or suffers his employer to be imposed on, not only is his character at stake, but he is also amenable by the laws of his country (and very properly); so that following the profession of an architect, not being duly qualified, may be attended with the most serious consequences; for whether an architect allows his employer to suffer from inattention on his own part, or from the ignorance or dishonesty of the persons employed by him, it is precisely the same in effect, he being profes-

sionally employed, and receiving his commission on the cost of the building, which is paid him for designing, directing, and superintending its construction, and seeing that the whole is performed in a proper and workmanlike manner, examining and passing the accounts, and making every arrangement for their final settlement. Consequently, in case of failure in any respect, he is answerable, from whatever cause it may arise, except the improper interference of his employer. Independently of this serious responsibility, if he does not qualify himself in the operative part, it is impossible that he can ever follow his profession with any comfort or satisfaction. Even in passing over or through his own buildings, he is obliged to be most careful of giving any directions, fearful lest he should commit himself before the common mechanic, who very soon discovers if the architect has practical knowledge, and consequently in what manner the work may or must be done, and acts accordingly.

It may be stated that architects of extensive practice cannot attend to all these things themselves. True; but be it remembered, that young men do not very soon get into such practice, particularly if they are not well qualified; and when they do, it is the more essential that they should perfectly understand the practical part of their profession,—that they may select proper assistants, and having chosen them, that they should know from their own experience if they perform their duty with ability and integrity.

This treatise was commenced originally for the purpose of giving the pupils studying under the author, who had an extensive country practice, a correct idea of measuring, abstracting, bringing into bill, and valuing the different artificers' works, agreeably to the methods considered by London surveyors as the most correct and expeditious. The great talent and extensive practice of metropolitan surveyors must be allowed as sufficient authority for concluding that the rules laid down by them are superior to any others that can be adopted. Independent of which, it being the practice for the architect, or his clerk or surveyor, to meet the surveyor appointed by the tradesman to take the dimensions, abstract their contents, make out the quantities into bill, and value the work together, it is absolutely necessary that a regular system should be adopted and strictly adhered to in every part of the business, or much confusion would arise, as is generally the case whenever London surveyors have to meet country practitioners; and it is consequently of the utmost importance to establish the same system throughout the kingdom. The great improvements made in travelling, and the velocity with which we are now conveyed, will soon place every part of this country within a few hours' journey from the metropolis; and the natural consequence of these increased facilities of communication must be, that our habits and methods of doing business will proportionally assimilate.

It is not intended, in this part of the work, to

explain the methods of manufacturing any materials, as bricks, tiles, &c., or the methods of performing the respective works, except so far as to enable the young student to describe the work which he is about to measure, and to ascertain if it be executed in a proper and workmanlike manner. But a perfect knowledge of this department can only be obtained by great attention, perseverance, and practice. The method is shewn of valuing all the leading articles in each trade, by first ascertaining the fair price to be allowed for the materials, according to the prime cost thereof, and by adopting what the author considers the ne plus ultra, viz. a decimal; by which, if correctly ascertained, the amount of labour thereon at all periods may be immediately found, by multiplying that decimal by the rate of wages allowed: this is the only method by which perpetual prices can be formed. Materials and labour are continually, but not proportionally, fluctuating; consequently the value of work can only be determined by first ascertaining the cost of the materials expended, and making the requisite allowances for profit and waste, and then the amount of labour in executing it.

As the tradesmen's bills must be passed and signed by the architect, the prime cost of materials may in most instances be obtained without much difficulty, and in all cases may be demanded before he allows the prices charged. The quantities required per rod, perch, square, or yard, according to the description of work, the architect ought, agreeably

to certain rules, to be capable of determining. But many difficulties arise, and the greatest attention is requisite to ascertain correctly the fair average of time to be allowed between the common and best workmen, and also between what men can, and what they will, do. The decimal must therefore be calculated agreeably to our respective judgments, and from the best information we can obtain; the correctness of which depends on the attention we have paid to the subject, and the opportunities we have had of arriving at our conclusions. Those which are now submitted to the public will be found as correct as they can be made in the compilation of a work like the present. It is anticipated that the professional man may, in his advice to the student, be induced to place this subject properly before him, and establish rules by which every description of work may be valued, according to the prime cost of materials and the rate of wages, at any time and place when and where the work has been performed.

ON MEASURING.

In order to illustrate the principle of measuring the different artificers' works, drawings of reference are given, as the only means of conveying to the architectural student, who has never attended to the admeasurement of work, the correct method of proceeding. The description of book generally used for measuring is shewn, with lines ruled according

to the old practice: few modern surveyors, however, think of ruling the columns for the dimensions, any more than they would rule lines to write by, it not being more requisite to those who are in the constant practice of measuring work; but it is always customary to insert the date and the name of the person met, and also for whom, and where the work is done, in the manner hereafter described.

In entering dimensions in the measuring-book, observe that the number of times is always stated on the left of the dimensions; and in measuring brickwork, the number of bricks in thickness on the right side; leaving another space or column for the amount the dimensions square to. Also be particular in entering the wastes in the book; that is, the manner in which the length and width of each dimension is made out; which is frequently done by collecting several together; and likewise the particular situation of the work; so that the student may be able to account for or make out how every dimension was taken, should any misunderstanding arise at a distant period, and he be called upon to give the necessary explanation respecting the way in which he has taken the work: he will then be as ready and quick as it is necessary to be correct.

ABBREVIATION.

Every method that can be adopted to expedite the taking of dimensions with accuracy is most desirable.

It is recommended to the young student to attend to the following practice; viz., using a kind of short-hand or abbreviation in describing the different works, which greatly facilitates the operation, and gives time for more attentively observing the measuring rods, to know from ocular demonstration that the dimensions are taken and called correctly; which all who have had much practice in measuring find to be very essential in correcting inaccuracies, from whatever cause they may occur. Although it may appear that this method of adopting initials is not sufficiently explanatory, they will, with a very little practice, be read and understood with as much ease and certainty as if the words were written at full length. In this, as in the other departments, details are given to each respective trade.

ROTATION.

No profession can be successfully pursued without adopting a regular system; and in no department is this more essential than in measuring the multifarious works in a building, which can only be accomplished with any degree of accuracy by invariably taking the respective works in regular succession, by which it is scarcely possible to omit any part of the work, which would constantly occur if some positive and undeviating rule were not attended to. In the following pages, the regular rotation to be adopted in measuring each particular description of

work is given under the heads of the respective trades.

ON ABSTRACTING,

AND BRINGING THE QUANTITIES INTO BILL.

The form of the abstract is drawn out for each trade, and also the rotation that should be observed in placing the particular kinds of work, which, if constantly attended to, will greatly facilitate the operation, as it is always known in what part of the abstract any description of work will be found: this more particularly alludes to the abstract for carpenters and joiners' work, where there are so many different heads as to make it absolutely necessary to pay the greatest attention to their order and regularity. This and the peculiarities to be attended to in each trade, are more particularly described at the commencement of their respective abstracts. The student is to observe that, before he begins to take out the quantities, he prepares the abstract, by considering what articles he will have, and writes the heads of them in their proper columns, according to the rotation to be observed in bringing them into bill. On this subject examples are given in each trade; but the general rule to be attended to in such trades, where some of the work is valued by the rod, perch, yard, or square, is to place these first, and next the work valued by the cube foot, commencing with the quantities on which

there is the least labour, and so in regular rotation to those that have the most. Next proceed with the articles that are valued by the superficial foot, commencing with the lowest, and, as before stated, to those of most value; having entered all those by the foot superficial, then take those by the foot run in a similar manner, and next those that are numbered, as is more particularly described after their respective abstracts.

VALUATION.

In entering on this department, it is imperative to impress on the mind of the young student the absolute necessity of being circumspect and correct. If he intends to maintain his independence and be respected, he must make a point of conscientiously doing his duty with strict integrity; to accomplish which it is not only essential that he be honest in his intentions, but that he should be qualified for the business he undertakes. Whether an act of injustice arises from ignorance or intention, it is precisely the same in effect; it therefore behoves him on every account to be qualified for acting on his own judgment. But he cannot consider himself competent to measure and value artificers' work, unless he understands the nature of that work, the manner in which it is executed, the time required to perform the same, and can ascertain the prime cost of the materials used thereon at the

period when the work was done. It is only possible to state the time and materials that should be expended in the several works taken on an average, but which will vary according to the description and execution thereof, both as regards the materials used and the ability of the workmen employed. It is the duty of the architect to take all these circumstances into consideration before he affixes a value on the work; consequently, in this department, the greatest care, attention, and judgment are requisite, to do justice to all parties. To give the student the necessary impetus for acquiring these essential qualifications, was the author's principal motive in offering this work to the aspirant.

CONSTANTS OF LABOUR.

These constants represent the time requisite to perform a given quantity of work, of the kind specified, in days and decimal parts of a day; the factor to be applied, being the rate of wages per diem for one or more men, according to the nature of the work.

These decimals are calculated, in all the trades, for the price per day allowed the master in his day bills, consequently with his profit thereon, being the only rate that can be ascertained, the master of course paying each man per week according to his abilities and industry; therefore the full value of the labour, including the master's profit, will be

found by multiplying the decimal by the rate of wages, as shewn in their respective tables. Likewise, in all cases it must be understood that the prices stated in the tables for labour and nails include fixing; and when added to the price of deals, calculated as shewn in page 64, will give the value of the work fixed complete, including labour, nails, and materials, according to the prime cost of materials and rate of wages allowed.*

* As artisans commonly regard the use of decimals as something *more complex*, instead of *simpler*, than the roundabout operations of arithmetic with which they are familiarly burdened by our present clumsy divisions of measures and money, we will give an example of the use of these decimals. Let us suppose that at a certain place and time the wages of a joiner are 6*s*., and we wish to find the fair price for making and fixing a six-panel door, moulded on one side, 7 feet × 3 ft. 6 in. × 2 in. We find, in the Table of Constants for a two-panel door, of this thickness, .070 per superficial foot; that is, the time fairly allowable will be, for each superficial foot, 7 hundredths of a day. If it were more than a whole day, the number of *days* would be placed before the decimal point. As we have here no figure *before* the point, and only an 0 in the place next after it (the place of *tenths*) we allow no days, and no tenths of a day, but 7 hundredths, and no thousandths (the 7 being in the place of hundredths, and the last 0 in the place of thousandths). Again, we are directed to add for every two additional panels, if moulded on one side, .012, the double of which (for our four panels) is .024, or no days, no tenths, 2 hundredths, and 4 thousandths of a day. By adding then .070 to .024, units to units, tenths to tenths, &c. (which is insured by keeping the decimal points under each other), we get .094 for the constant of labour, per foot, to a two-inch six-panel door, moulded on one side. The number of superficial feet in our door being $24\frac{1}{2}$, we must, for the amount of labour to the whole, allow $24\frac{1}{2}$ times .094, which is 2·303, found just in the same way that we find $24\frac{1}{2}$ times 94 to be 2303. For, because the *last* figure in 94 expresses 4 *units*, when we have multiplied 94 and

got 2303, the *last* figure in this also expresses *units*, whence, by numerating backwards, we find the 2 to be *thousands*. Now suppose our two figures 94 were made to express ten times 94, by adding a 0, thus 940, that is by simply shifting them back one place, the 4 from units' place into *tens*, &c. On performing the same multiplication, we should get the same four figures, 2303, but the last of them would now stand for *tens*, thus, 23030. The use of a final 0, or any number of final 0's (as in 12000), is only to *shift back* the other figures one or more places further from the unit's place than they would otherwise be. Now, as we here shift them back, so we may contrariwise shift them *forward*, by the simple contrivance of the decimal point, which always signifies that the figure next before it shall be taken for units, or that next *after* it for *tenths of an unit*, and so on. Thus the figures 94 may be made to signify ten times *less* than 94, by shifting them forward one step, thus, 9.4 (9 units, 4 tenths); or again, ten times less than this, by shifting them another step, thus, .94 (*no* units, 9 tenths, 4 hundredths); or still ten times less, by another remove, thus, .094 (no units, no tenths, 9 hundredths, 4 thousandths); and because the last figure here stands for thousandths, if we get, by the above multiplication, the four figures 2303, the last of these will be thousandths; whence numerating backwards, we find the 0 to be hundredths, the first 3 to be tenths, and the 2 to be units; which we express by putting the point between units and tenths, thus, 2.303. Thus the time an average joiner should be paid for this door is (including master's profit) 2 days 3 tenths and 3 thousandths of a day. And thus the whole joiners' work throughout the largest building may (apart from materials) be summed up, and brought into one number, expressed in days and decimals of a day. So also with the masons' or any other labour for which we have a set of decimal constants.

We have then only to multiply the day price of each kind of work by the number of days of that work found as above. Thus the joiners' labour being worth, as we have supposed, 6*s*. a day, 6 times 2.303 will give 13.818 shillings, or about 13*s*. 10*d*., for the labour on this door; the means of reducing the .818 of a shilling to its value in pence being obvious to any one acquainted with common division, and who bears in mind the nature of decimals as above explained; and the frightful waste of time on such operations being inevitably fated to disappear by our *certain* yielding, sooner or later,

to the French (or rather the universal civilized) division of money, weights, and measures, by tens, instead of our present ridiculously discrepant divisions, which probably create for amusement double or treble our necessary arithmetical labour.

For rules applicable to all such operations, see Weale's "Rudimentary Arithmetic," p. 112, &c.

BRICKLAYER AND SLATER.

TECHNICAL TERMS, AND REMARKS ON BRICKWORK.

THE *beds* of any masonry are those joints that run in planes perpendicular to the pressure it is built to resist or transmit.

Hence they are obviously the only joints whose number or extent is immaterial to the strength of the work; and for convenience in erection they will commonly extend uninterruptedly through it.

A *course* is the whole layer comprised between two beds.

In an ordinary wall the beds and courses must be horizontal, because the pressure is vertical; in an arch or vault they must be radial, because the pressure acts along the curve; and in a buttress or a retaining-wall they must slope downward from the outward face,* at right angles thereto, because

* The mediœval church-builders neglected this in their buttresses, because, having properly broken their general slope into several abrupt slopes divided by intervening vertical surfaces, for the sake of protecting the joints from the weather, it would have entailed much extra labour to make the beds, which begin horizontally at the outer face, take up an inclined position in their interior. In modern imitations this would be the less called for, as they are only mimic buttresses, having no real office.

the pressure is or ought to be parallel to that face (supposing its inclination truly designed).

In this last case, the *batter* is the deviation of the face from a plumb-line, or of the courses from horizontality, expressed in so many inches per yard or ten feet.

Brick *bond* signifies the binding together of two adjacent bricks in the same course, by one brick in the next course pressing on both. It therefore requires that every joint which is not a bed shall be confined to the thickness of a single course, and be as far as possible from coincidence with any joint of the next course above or below. The attention to this (which is equally proper for other reasons in other kinds of work) is in all cases called *breaking joint*.*

Bonds are systematic ways of arranging bricks so as to insure breaking joint throughout the work. They depend therefore on the form given to the beds or largest faces of the bricks, as square, triangular (both of which were tried by the ancients), &c.; but moderns have generally admitted the best form for bonding to be a double square or oblong

* As the bed-joints are the only ones that do not weaken a work, the joints in any other directions than these should be as few and small as possible, which is insured by laying every piece of material with its two largest faces in the direction of beds. Again, as all faces inclined to the direction of the pressure would act as wedges to drive each other apart out of the work, all joints not in the direction of beds should be perpendicular thereto; which is insured in all brickwork (except some very recent "model" absurdities) by making the bricks with all their smaller faces at right angles to the two largest.

of twice its breadth, which in England is made 9 inches by $4\frac{1}{2}$ (the finished brick being always less, from the contraction in burning). Their thickness obviously cannot affect the method of bond; though the thinner they are, the more effectual must any bond be, because the oftener repeated. This advantage of thinness, however, has its limits in the fragility of very thin bricks, and the increase of labour and mortar with the number of courses. Still, a thinner brick than our ordinary one of $2\frac{1}{2}$ inches, would undoubtedly make stronger work; and hence a late eminent constructor preferred the *pavers* (bricks made for paving, only $1\frac{3}{4}$ inches thick).*

* To get the full advantage of thinness, however, an increase of the other dimensions would be necessary, so as to preserve the weight most convenient to handle, which answers to a bulk of about 100 cubic inches. A nearer approach to the proportions of the Roman bricks would certainly improve ours; and were they made 12 inches × 6 × $1\frac{1}{2}$ (a common shape in antiquity), it is probable that a 6-inch wall would answer all the purposes of a 9-inch *provincial* wall at present, and a 12-inch one certainly all the purposes of our 14-inch, and be even much stronger. We speak of *provincial* brickwork only, because that of the metropolis forms a *genus per se*, admitting of no exact estimation like other kinds of work; it having so universally degenerated, that (unless by importing labour from a distance) architects have no alternative but to substitute quantity for quality. See Bartholomew, "Practical Architecture," § 353.

Such bricks might be further improved, and mortar economized (or in some cases even superseded), by giving their bed faces an undulation, or furrowing of parallel *waves*, crossing them diagonally, those on one face at right angles to those on the other. With a properly shaped brick of this sort, the whole first course (of a rectangular building) could always be so laid as to present a continuously furrowed surface, on which the second being laid in any bond now used, would fit exactly, wave into furrow, and present a new surface furrowed similarly in the contrary direction, and so on; giving all the connectedness of the courses of the Eddystone.

Bricks lying longitudinally in the walls are called *stretchers*, those lying transversely *headers*.

In *Old English bond*, which is every way the best, stretchers alone appear in the face of one course, and headers alone in the next course, and so on alternately.

In *Flemish bond*, each course is alike, presenting a header and a stretcher alternately;—an appearance now thought so essential, that for its sake, the solidity of all visible parts of brickwork is greatly impaired.

In English bond, none but whole bricks need be used; except that at each angle, to make the courses terminate vertically over each other, each alternate course must have, if of stretchers, a *quarter* or *three-quarter brick*, and if of headers, a *half-brick cut longitudinally*. These expletives, which are equally necessary in all bonds, are called *closers*, and are placed last but one, that the angle may always consist of whole bricks.

In Flemish bond, many broken bricks besides the closers are necessary, and most so in walls of the most common thickness, or $1\frac{1}{2}$ bricks; in which so many fragments are required throughout the body of the work, that the joints are not broken at all in the middle third of its thickness. As all work out of sight is built in English bond, the junction of the two incongruous systems is a further source of cutting and unsoundness; and altogether the "Flemish bond" fancy, however little it may gratify (or even be observed by) general spectators, is in fact a very expensive decoration, comparable with a whole sur-

face of tracery or inlaying, and decidedly the most costly architectural ornament ever brought into general use.

Footings are all such foundation courses as are wider than the body of the wall above. Being all centrally over each other, and diminishing by half a brick at a time, they can only leave steps (called *offsets*) of ¼ brick on each side; of which one *at least* is, in all civilized architecture, visible above ground, that the building or wall may not appear baseless, and finished with a course of bevelled bricks or stones to throw off the water.*

The visible footing is called a *base*,—its lower upright portion a *plinth*; and the neater finishing or adornment of the bevelled course (which will only admit such treatment where the upper parts of the building are considerably enriched) renders it a *base-moulding*.

Sleeper-walls are those built at intervals across the lower rooms, to support their floors; if paved, by arches; if of wood, by joists lighter than would be needed to cross them in one span.

Inverts are inverted arches, an essential member of nearly all good and economical foundations, being properly placed *under* all openings, for the converse

* No tribe, we believe, has advanced beyond wattled huts without developing this feature; and no amount of sophistication and pseudo-refinement, short of a return *beyond* savagery, to absolute materialism,—or *animal* architecture, like that of the beaver,—can be conceived to suppress it; as the saving of material in making a foot of walling half a brick thinner is too trifling to have influenced the most sordid.

reason that we place common arches *over* them. For an arch, no matter in what position, affords the means of opposing to each other a diffused pressure or resistance against the whole of its convex side, and two single concentrated pressures or resistances at its ends, without requiring any against its concave side. The former resistance is here that of the ground upward, afforded equally at every part of the footings; and hence, when the downward pressures on them are partial, as from columns or the piers between windows, these masses should always stand on the ends of inverted arches extending under their intervals.* Even the piers of bridges will, wherever permanence is aimed at, be thus connected; as in the remaining bridges of Rome, where the arch above and that below the bed of the river form a complete circle.

In general, the best curve for inverts is a third of a circle.†

* Arches should also be applied in any position where the same conditions apply. For instance, at the back of a row of London coal cellars, where the pressure of the earth against the whole wall has to be opposed by the resistance of the partition walls meeting it at certain points only, the portion of material between every two of these is curved, convex toward the ground, and forms a series of true arches *laid on their sides*, as inverts are *on their backs*.

† But *over* another arch they should repeat its form, only compressed in depth if necessary; as in those splendid ones added to Salisbury and Wells Cathedrals, which are pointed, and which have for nearly six centuries preserved those piles from otherwise inevitable ruin. The Gothic builders also recognised their use as an improvement on straight window-sills, as we see in the second tier round Westminster Abbey and many others; all alike evincing how completely, by a studious *organising* of these (as well as all the other)

Though essential to true economy, in every case except building on a rock, inverted arches are rarely now used; and when they are, it is often without knowing why. This is betrayed by the substructure having extra thickness under each pier; which can add no strength, since the inverts are useless, unless so formed as to distribute the weight over the whole length of the foundation, which then requires equal strength everywhere, and, if insufficient under the piers, is just as insufficient under their intervals.

The other arches still retained in brickwork are the semicircular, segmental, and straight. The segmental is called a *scheme* arch, when its joints all radiate from its centre of curvature, so that the bricks of the arch are all similar. It is called a *camber* arch when, the curvature being very small, the centre is distant, and, to obtain a greater divergence of the joints, they are drawn from another point nearer the arch, which obliges the bricks to be all cut to different shapes.

Semicircular and *scheme* arches admit of being built with ordinary bricks, not even wedge-shaped, and in this case are called *rough* arches; but in these the brick (being parallel-sided) performs only

members of their work,—a detailed adaptation of them to their functions,—they succeeded in making them *fit to be seen* in any company, however ornate; a problem they seem to have considered the first in their art, but one which the architects and engineers of Imperial Rome did not, and those of modern Europe do not, any longer attempt, because it saves trouble, and better answers their end, to *hide* or *suppress* than to organise.

the office of the mortar in proper arches, and *vice versâ*, the mortar (being in wedge-shaped pieces) forms the real voussoirs or arch-blocks; so that the utmost strength attainable in such arches is only that of a similarly shaped solid mass of the *cement* used in them; while proper arches may be as strong as a similar mass of the *brick* or *stone* of which their wedges are formed.* Rough arches should

* The former kind of arch resembles in this respect a rubble wall, the cement being the essential material, and the bricks or stones merely used to economize cement, by occupying its room; while in a proper arch, on the contrary, as in a wall of coursed rectangular masonry, it is only the blocks which are essential, the mortar being simply used to save the labour of bringing them to a perfect fit. Were this done (as it was in certain Grecian works, by polishing the faces that meet), cement would in nowise enhance, but rather impair, the solidity of the work; and in all cases of *building* properly so called, the functions of the mortar would be equally answered by dry sand, if it could only be retained in its place. Where this is not so, or wherever *adhesion* is called into play, the work is not properly *building*, but *concretion*.

There is a great tendency in the latest works of declining Roman art, and a still greater in those of the present day, to substitute everywhere *concretion* for building proper, and indeed for *construction* of any kind. This will be plain if we remember that building proper is no less distinguishable, on the one hand, from concretion, or sticking together, than, on the other hand, from *framing* or tensile construction; and it is distinguished from both by the single property of having all its parts compressed, or being free of all dependence on the *tenacity* of any of its materials. Both concreted and framed works depend on the resistance of some part of their substance to a stretching force; but with this difference, that, in proper *framing*, every piece of material is subject either to direct compression alone, or to direct tension alone; the whole being designed with a division into compressile and tensile parts, and all adjusted to their respective strains; while in *concretion* this is left to chance, each part undergoing a complication of indirect strains of both kinds, or each in

have the lower angles of their bricks in contact, the cement thinning away to nothing there.

Cut arches in brick, as now executed, are commonly inferior even to *rough* ones of the same shape, as the softest and weakest kinds of brick are chosen for ease in cutting. Hence it is greatly to be desired that advantage were taken of the removal of legal restrictions, by reviving in large towns the practice (still surviving in many rural districts) of building arches with hard kiln-burnt bricks originally *made* wedge-shaped. In Suffolk, and other brick counties, these are still used even for *camber* and *straight* arches with great advantage, as the cutting the upper and lower *ends* of the bricks to the designed

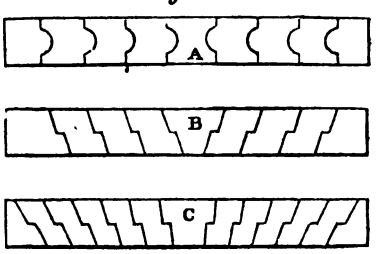
turn, as accidental circumstances may determine. The lesser degree of design or of organization, therefore, in this kind of structure, renders it (however unavoidable and proper in such minor matters as clothing, pottery, &c.) an indication, when used in great and fixed works, of very corrupt and declining art and skill; if indeed it be not, in its purity, simply characteristic of the work of brutes.

Examples of these three varieties of structure will readily occur to the reader, though it is very rarely that works of any extent do not present a mixture of all three. An ant's nest, or any animal architecture, is an unmixed instance of *concretion*, and so is (in a greater or less degree) a pisé house, a suspension bridge, tubular bridge, or "Crystal Palace;" the difference of sticking together, or sewing or rivetting or screwing together, making no difference of principle. Again, a statue's pedestal is the simplest case of unmixed *building*, and to the same class belong London and Southwark Bridges, the roofed temples at Nismes and Baalbec, the Pantheon, Milan Cathedral, and Redcliffe Church, Bristol, (the two latter being by far the highest or most artificial developments of it hitherto). Lastly, a reading-desk, a bridge-centring, Palladio's Cismone bridge, or the late London Bridge railway shed (now destroyed), are pure instances of *framing*; but this is very rare in England, owing to the rapid modern tendency to *concretion*.

shape is both less in amount, and requires less exactness, than the cutting of their bed faces, as done, or pretended to be done, in the sham building of towns.

The *straight arch* (of which a representation is still thought necessary over all our domestic windows) was the last remnant of the contrivances invented for carrying such apertures up as near to a flat ceiling as possible, without using wood to support masonry; which was *never* done, or deemed allowable, in times or places of rational building. (See Petit on Church Architecture, vol. ii. p. 3.) On the first application of masonry to domestic buildings this was effected by an arch of ordinary shape rising above the ceiling (if necessary, into the story above), but filled in, down to the ceiling level, by a thin walling like the tympanum of church doors, and upheld, like that, by either a lintel of stone, or some such artificial lintel, in small pieces, as these here represented.

Fig 1.

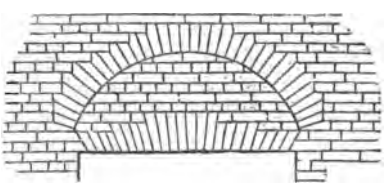


ARCH-FILLING BEARERS: A from the door of Rochester Cathedral; B from Conisborough Castle; C from the Alhambra.

The last form (which differs from the second in having all the joints divergent from one point, instead of being all equally inclined) corresponds to

a "straight arch;" and the steps or joggles, at first retained from timidity, were soon found to be needless, where the depth was sufficient to allow an arc, described from the centre of divergence, to cross all the joints, and where the substructure was sound enough to obviate all chance of the piers settling apart or being thrust out. Hence we arrive at the common straight arch, a form as easily constructed in brick as in stone, and which still subsists (or did till lately) in those English districts where the best bricks are made. It must be remembered, however, that its self-supporting quality resides solely in the arc above mentioned, that all the material below this arc is merely a suspended burden, and that the proportion of effective material compared with the ineffective is very small,—the greater part being not *supporting*, but *supported*. Hence the straight arch was never made a bearing member: originally and properly it never bore a superincumbent wall, but only the thin *tympanum*, or *arch-filling*, reaching up to the proper curved arch above, which was the first and most essential part of the work.

Fig. 2.



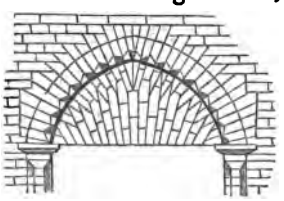
This, then, was the point attained when the fall of the arts cut short further improvement.* Pre-

* It is remarkable that in antiquity the straight covering seems to have reached this same degree of development, and no further

sently the wretched pedantry of the "Renaissance," called for the concealment of the upper arch as "*unclassical*" (*i. e.* unmanageable by architects without designing for themselves). Once concealed,

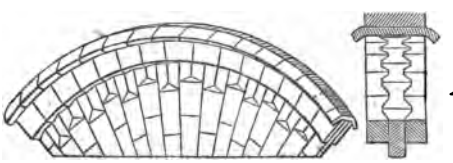
(to judge from some examples in Diocletian's palace). In such cases it is difficult to abstain from speculating on what the next step would have been, had progress continued. Would not the radiating joints of the lower or upper arch, or both, have been continued across the intermediate filling, so as to render all its parts alike self-supporting? This would have obliterated the distinction between the straight arch and the filling above it, thus—

Fig. 3.



but the upper arch, having the superstructure to bear, must always, in unaffected architecture, have been stronger or thicker than the filling, so as to overhang it on both faces. Hence it might be formed by an extra layer of material added to each side of the single layer, always sufficient for the filling, which is a mere screen. And hence the three layers might next be so formed (more easily in brick than in stone) as to interlock, in the way shewn below, and form an arch *without lateral thrust*, provided the tendency of the three layers to separate transversely were restrained by an upper course of *headers* with downwardly projecting ledges, embracing the whole thickness of the arch; and one of these ledges might also project, and be so formed as to serve the purpose of the old label, drip, or hood-moulding. Of course any artist builder would find in these utilitarian arrangements room for all the real ornament and variety that could possibly be desired.

Fig. 4.



A

A, back of arch, with half the upper course of headers removed.

the dishonesty of a corrupting art was not slow in learning to omit it altogether; and it came to be regarded (under the name of a *discharging arch*) as a mere refinement for superior work. The straight arch, loaded with the whole superstructure (for which it had never been designed) soon betrayed its insufficiency. The remedy chosen in this country (but, we believe, in no other,) was characteristic. The arch was reduced to a *dummy*, and its office delegated to *concealed* wooden lintels; brickwork (the first kind of work to lose its self-respect, and always ahead of all other in the downward race,) being no longer ashamed to depend on the first and rudest makeshift another craft might lend it. Thus walls of masonry condescended for the first time to stand on shrinking, rotting, combustible sticks. And it only remained for the "insurance principle" to be perverted to evils produced by human agency,—for mind to strike its colours openly to matter, prudence to improvidence, and purchase peace with them by a fixed tribute,—it only remained for this base surrender to destroy the motives to *real* insurance; and then for the window tax, by distending each grudged hole to its utmost contrivable dimensions, to perpetuate these disgraceful shifts, and to fossilize English domestic building in that form of unsurpassable baseness and irrationality which it has retained for the last half-century; to present the phenomenon of a city with almost every wall or roof or window, sinking, cracking, bending, proclaiming failure;—augmented by scores of build-

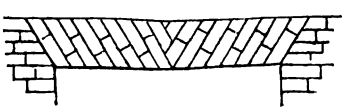
ings daily, all precisely similar;—learning nothing or gaining nothing from the experience of perpetual failure.

Gauged Brickwork is that which has the bricks wrought to smooth and accurately-fitting faces and joints, like stone, by sawing and rubbing. In the sixteenth and seventeenth centuries whole works were thus constructed or faced; but unless the method be carried throughout a wall, it is highly objectionable, the wrought and unwrought bricks being necessarily unequal, or the cement settling unequally and tending to dislocate the whole. Gauged work is therefore now quite abandoned, except sometimes for certain parts, which, from their importance to the structure (as quoins, arches, &c.), it is pleasing to distinguish from the rest by superior (or apparently superior) materials or work. As a score of bricks or stones could be better spared from the body of a wall than *one* from an arch, a quoin, &c.,—as their value thus varies with their position, like the value of a figure in arithmetic; it is natural to bestow more attention and work on those occupying important stations than on those standing only for units; and to choose for them the better or stronger material, when we have a choice. Hence the mere appearance of this having been done is taken as an evidence of thought or design, and so is pleasing or ornamental; whence arise the modern kind of ornaments called *dressings;* and, in mock architecture, the practice of distinguishing these from the rest of the surface, even at the expense of their stability;

for the gauged brickwork often used in them, though apparently better, is really *weaker* than the ordinary brickwork surrounding it, being made of far inferior bricks for the sake of ease in cutting.

Gauged arches are the imitations of straight arches retained over our windows, as above mentioned. Being of the softest obtainable brick, cut and rubbed with reference only to the appearance of the visible faces, and not to the fitting of the joints (for they are even measured and paid for by *superficial* and not cubic measure), they are the weakest parts of the buildings containing them, though unhappily placed just where strength is most needed; and their perpetual fracture seems to be regarded in London as a matter of course. When straight, as they usually are, the only chance of avoiding this (where there is no real arch above, as in Fig. 3.), is by the singularly clumsy expedient of upholding the superstructure corbelwise, by a course of headers next above the "arch," resting on the wooden lintel behind, which it is the sole use of these "arches" to hide, as the metropolitan building laws do not allow the exposure of wood in the external face of the work.

A "*French arch*" is the *nom de guerre* for the following arrangement of common bricks, which (stuck together with a cement tenacious enough to keep them from falling) is now frequently palmed

Fig. 5. 

off, in buildings intended to be dressed up in plaster, and (to judge from the thousands observable round London) succeeds in tricking many persons out of even the wretched stop-gaps above described.*

Skew-backs are the inclined surfaces necessary to receive the ends of any arch that makes angles with its supports, as a straight or a segmental arch. For the sake of accuracy they often, in work composed of coarse irregular bricks, have to be made in stone or cast iron.

The proper mode of connecting the masonry of an arch with that of the wall above it, is by cutting the arch-wedges alone, and not the courses of the wall, (see *figs.* 2, 3,) so that the latter may bear on horizontal beds, and not be tending to slide down the slope of a curved extrados or arch-back; and this best method is also, in brickwork, the cheapest, or involves least labour in cutting, because the arch bricks are always of a finer grain than the wall-bricks, whether softer or not. As this, however, involves *a design*, and the false method requires none, we cannot wonder that the latter is the only mode in use; as, with the present fictitious and exaggerated disproportion of price between mental and manual labour, it is an object to save the former at *any* cost.

* It strikes us that, in experiments on beams, this contrivance might be useful for concentrating the whole of a superincumbent weight on the beam's centre. Its introduction into building of any kind, human or animal, is certainly a startling mental phenomenon, and must be hardly credible to those who have not seen it, which they now may in any of the metropolitan suburbs.

Bird's mouth is any re-entering angle that requires the bricks to be notched (Plate I., fig. O.), and is paid for by the running or lineal foot; other cuttings (as for backs of arches, &c.) by the superficial foot.

Reveals are the surfaces receding from the outer face of a wall, back to the window-frame, and are required by the London Building Acts to be at least half a brick. Before this regulation, it seems (from the houses of the last and previous century remaining about the Inns of Court and similar places) that our sashes were placed out in the same plane with the face of the wall; though all other nations seem rather to keep them as far back as possible, either for shelter or solidity of external appearance, or both; and it has been well observed that, except for idle people to look out of window, there is no reason for this English peculiarity, (which, by the shallowness and baldness produced externally, quite defeats all architectural effect,) but, on the contrary, as much utilitarian as artistic reason for keeping back the glass a whole brick or more, as on the continent. The only objection made is, that internal folding-shutters could not, without more waste of room than at present, be so arranged as to counterfeit (with the aid of curtains to conceal their projection from the wall) the effect of an embrasure through the thick walls of the olden time, which is deemed a "comfort;" but the rational and really comfortable plan seems to us to be, arranging the shutters in the way that will take least room, not

that which will best aid the fancy to so wretched a self-delusion.

Indeed, this may lead us to a general notion why it is that the boasted untranslatable idea of "comfort" is always inimical to good taste and art. The English "comfort" is evidently a complex idea, or a term expressing more things than one; because, in its commonest sense, that of physical well-being, it cannot be peculiar to any nation. All must know and appreciate what is comfortable in this sense as well as ourselves. If there be any "comfort," then, which is untranslatable, it cannot be this; but must be something else, little esteemed by others, but so dear to the Englishman that he confounds it with physical well-being—actually gives it the same name. Now this something will be found, I believe, always reducible to the desire to have, or appear to have, or fancy we have, things similar to those of richer neighbours—similar, that is, in *kind* or in *name*, no matter how inferior in quality. The prouder and (among mankind generally) the commoner boast would be to have things which, though of a different kind, might be as good in their kind as his Lordship's, or Her Majesty's things in *their* kind. But the English passion always is the reverse of this; to have the very same kind, or form, or appearance of thing as our betters, or such as we may call or fancy the same, no matter how inferior or how wasteful or inconvenient;—and it is one of the ridiculous sophisms of those who fatten on this folly of their neighbours, to talk of the benefit done to

the many by cheapening these so-called "comforts" of the million, as if the million were anywise bettered by having bad silk in place of good cotton, or bad plate-glass in lieu of good crown, sham stone in place of real brick, or sham carvings in place of real mouldings—by being in everything inoculated more and more with a demoralizing taste for all counterfeits, tricks, and deceptions. It is difficult to conceive anything more levelling, and destructive of all excellence in arts and manufactures, than an idea of "comfort" thus tending universally to a choice of the cheapest thing of a superior kind, rather than any, however good, of an inferior kind —a choice utterly incompatible with true taste, which (it has lately been well observed) always takes the best of a lower kind, rather than an inferior thing of a higher kind, and is consistent with all upright and straightforward principles; while the contrary rule is unmanly, apish, and tends only towards brutish equality, and to monopolize for any nation labouring under it, the manufacture and consumption of *the worst of everything*. In building, this result has been long achieved—"Si monumentum quæris, circumspice."

Plates are the horizontal layers of material that receive the ends of flooring-beams and joints. They were, in the reasoning times, made of material as durable as the rest of the wall, but in larger or more accurately wrought pieces, and projecting inward, to offer a wider bed, and to express visibly (like all the other visible members) their use and

meaning; and the neat or ornamental finishing of their projecting portion produced the *internal cornice*, which we still think it necessary to counterfeit in plaster. The plates themselves, however, are now always of wood, and buried in the wall, unless where an offset or diminution of half a brick in its thickness leaves so much of their upper face exposed.

On this point it may be observed that there would be no waste in making the walls of all buildings, whatever their height, of such thickness at the base as to be diminished half a brick at every floor; and if this diminution were made, as at present, wholly on the inside, it would, with the assistance of real internal cornices of brick, permit the combustible and decaying plates and joists to rest upon, without *entering into*, the wall (the impropriety of which, in public buildings at least, is recognised in all countries but this, where masonry is used at all, and was recognised as early as in Solomon's time*). But a return to projecting incombustible plates, or real cornices, of finer brick or tile, would render the wooden plates unnecessary in moderately sound walls; — and certainly wherever the offsets are wholly inside, the whole wall should batter inward sufficiently to bring the offsets or cornices vertically over each other;—and where the walls are built not battering, the diminution should, on the contrary, be all on the outside, or at least equally within and without (as in footings), the outside offsets being

* 1 Kings, vi. 6.

protected by a bevelled course, or *water-table*, which ought, in good buildings, to project beyond the course below, and be *throated*, *i. e.* hollowed upwards underneath, to prevent the backward return of water-drops. This, like all other obvious features of utility, was of course, in the mediœval stone buildings, elaborated into things that modern times find worth aping as ornaments.

Besides the wooden lintels and plates, English brickwork (which, from being self-dependent, and the support of the less durable parts of a fabric, has at length come to be wholly dependent on what it once and properly sustained,) now calls in the aid of timber in the yet more absurd form called *bond*. The impossibility of obtaining moderate soundness in the *brick bond* itself having compelled architects to find some substitute, they have recourse to laying, at intervals of three or four feet, courses of timber, hence called *bond timber*. Engineers have been driven, for the same purpose, to iron hooping, imbedded among the mortar, and each length turned down into joints at its ends.

Bond timber is in fact only the modern form of a feature common to the walls of all times and places, whenever they are not composed of accurately squared masonry throughout; viz., a course or band of better, larger, or squarer material than the rest, placed at certain intervals, to bind what is below it, and furnish a renewed solid base to what is above. Such courses are seen in their simplest form in Windsor Castle, but were often made, in

the early Italian and Eastern buildings, an important part of the design, or even a source of rich ornament. They have not, as the eloquent author of the "Stones of Venice" supposes, fallen into disuse among us, but are simply, in accordance with our general tendencies, made of wood and concealed, instead of stone or brick and exposed.

String courses, in mock architecture, are, when not projecting from the wall, representations of the features last mentioned, imitated for their pictorial effect; and when projecting, they are similar parodies on the water-tables used properly where a wall was externally reduced in thickness. The former kind of string course, however, is now hardly to be seen, as in this country all ornament has hitherto been valued commonly in proportion to the degree in which it contradicts, hides, or apparently reverses whatever might be expected from the nature of the material or construction; and hence, when allowing a variety of materials to appear on the face of a wall as a means of ornament, instead of subordinating all such decoration to the horizontal band-work (as in the Italian and Eastern examples), we prefer to oppose all tendency thereto as much as possible, by patterns running diagonally, or dividing the wall into vertical disconnected strips, as pilasters, quoins, window-dressings, &c. The same taste for the impossible or contradictory may have been the source of our "Perpendicular Style," in which all horizontal members are stopped or cut short where they meet a vertical one, apparently for no other reason than

because the nature of masonry, running chiefly in horizontal courses, would lead us to expect the exact reverse, that horizontal lines should govern and stop the vertical ones. Indeed this latter is the case in all other *built* architecture, whether of brick or stone; and it may be easily shewn that the notion of the architects about a contrary rule, "verticality," applying to the Gothic school, is wholly unfounded, the "Perpendicular" being merely a vagary, and the government of vertical lines by horizontal being as complete in all the purest Gothic buildings as in Grecian or any other.*

The *External Cornice*, as the finale of the masonry of a building, naturally receives, wherever the neatness and finish is real and cared for, a large share of attention, and ornament, if there be any elsewhere, It necessarily consists of two parts; the upper being the projecting and protecting border of the roof itself, and the lower a *wall-capital*, or spreading upholding hand, identical in nature with an internal cornice, and commonly called the *bed-mould*. Though almost every rural parish affords proofs that this may be made in brick, even the common wall-brick, with far more character and variety than we can attain in all our plaster shams; yet brick is no longer applicable, or thought applicable, to this or any other purpose beyond mere *space-filling*, the production of dead inorganic masses; in fact, a mere kind of navvy-work;—a lamentable instance of the state to which

* Salisbury Cathedral is an instance.

mere commercial motives, left alone, may finally reduce what was once *an art*.

Chimney shafts are the only members yet unnoticed by us belonging to brickwork; and these are hardly satisfactorily producible in any other material, for, since the abandonment of specially contrived brick chimneys, nearly 300 years ago, the problem of letting out smoke seems to have been given up by the general consent of architects, who now evidently regard it as no part of their province, and suffer with perfect indifference their works to be crowned with the practical satires of the chimney-doctor. It has been suggested that the saving of cost and disgrace, in public buildings alone, would justify a series of experiments at the public expense, to determine the conditions that govern the efficacy of chimney outlets; but it seems possible, by taking advantage of what was already developed on this head, in the period of art-progress, to save the necessity of beginning our experience entirely afresh, as if chimneys were only discovered yesterday. Having been invented in Lombardy about the middle of the fourteenth century, they had time, before the perversion of the arts, to undergo a whole century of improvement; and were accordingly, in that country at least, if not in northern Europe, brought to a high state of efficiency. We have, *as yet*, no evidence of any failure to perform their function where the few and simple rules for their form, then developed, have obtained. These rules seem to have been (1st), that every flue should have its distinct shaft, detached

from all others; (2), that their plans should be circular, or polygons of at least twelve sides; (3), that they should be separated by intervals not less than half their diameter; and (4), that they should have enlarged and spreading capitals, either of a straight or concave outline, never convex, and never recontracting after attaining the maximum width, which should be at the upper edge;—the common object of these rules being apparently to offer as little resistance as possible to the passage of wind round and between the shafts, and to prevent or oppose all diversion of it *upward*, by which it might be condensed into a blast over their mouths. The strictest limitation by these rules is compatible with *quite* as much variety and fancy of design as modern architects have ever yet indulged in; and until it be proved by a fair trial that they do not ensure an effectual outlet, we have no right to ask for public experiments. It is our deliberate choice, when intrusted with the design of a building, to omit, for the sake of some ornament or other unnecessary work, an outlay which, as far as experience goes, appears necessary for the riddance of smoke. We omit this, seemingly for the simple reason that it *must* be supplied somehow, whether we do it or leave it undone; and by long custom the public has come to regard this as no failure in the architect's duty, but a matter of course, though he is theoretically supposed to provide for all necessaries of the work *first*, and for ornament only with what remains over and above necessary outlay. This then necessitates

the chimney-doctor's cobbling, to the immediate and entire defeat of all that the architect has been attempting, except utility in its narrowest sense,—the instant and flat contradiction of all his art, all his contrivances for unity, harmony, or completeness. He no sooner leaves his work than it is conspicuously, on the forefront, labelled 'Failure,' in gigantic characters on the sky-line. Yet no one concerned (unless the honest chimney-doctor) seems to see or blush at the stupendous hypocrisy thus disclosed on both sides; for how could the thing possibly come to pass if the "art," the "taste," governing the rest of the work were anything but pure pretence? How could it ever rear its ridiculous face to the daylight where either architect or public really cared one farthing for any of the things they have discussed so earnestly and paid for so liberally?—where one or the other cared really one straw more than a hog for any one thing or quality in the work, beyond the possibility of making use of it? Men do not incur vast pains and cost to make a thing thus or thus, because they *like* it thus, and then, for a comparative trifle, see all these pains at once defeated. Men who beautify a work because they care about its beauty, do not perform it so as, the moment it is finished, to be defaced. At least they do not, repeatedly and habitually, and after long experience, continue to do so.

Our English chimneys of the Tudor era have often bases and shafts of commendable design, but their tops, of mimic architecture, are barbarous, betraying

a taste that saw nothing, in heaven above or the earth beneath, better worth imitating than castle parapets. In Italy they very properly either imitated an expanding flower, or imitated nothing, but were simply shaped with reference to utility and economy, as the inverted truncated pyramids of Venice. The latter might be ornamented to any degree, and the former were *themselves* ornaments, being imitated from nature, as all real ornaments are. But imitations of human work, as miniature turrets or other features of architecture modelled *in petto*, have been justly condemned as neither utilitarian nor really ornamental, but every way base, apish, and evasive of the designer's real work.

Of the present English brickwork we need only add, that all its ugliness springs from irrationalities in construction, and would disappear at once if it were rendered again self-dependent, and the various contrivances required for this purpose treated with simple reference to their material ends. These would require the roof to overhang as a cornice, and thus to present a surface of incombustible material alone, which is very easy, though never attempted; the London roofs being, to avoid it, kept within the building in an absurd manner. The next absurdity is the fenestration, brought to its present state by the window-tax, which has taught us to do with about half or one-third the windows thought necessary in the same latitudes elsewhere. Now the removal of this tax, and of the restrictions on the manufacture of bricks, leaves no pretext for any one

of the peculiarities that have made our fenestration so unique in ugliness; viz., *fewness* of openings, excessive *width*, irregular positions *not over each other*, extreme *shallowness*, and the sinking or cracking *square top*. Even supposing habit to shut our dwellings against more light, or more quantity of window area, it ought to be divided among twice as many apertures. Of course, under a tax regulated by their number, not their quantity, it was expedient (though constructively absurd) to make them few and wide; but otherwise, every object, whether the equable diffusion of light in the room, or of strength in the wall, requires them just the reverse, numerous and narrow. Hence even the *temple* windows of all real architecture (which, like everything about a temple, were properly enlarged beyond the same features in a dwelling,) are yet, if not actually narrower, far narrower in proportion to their height than ours. This applies to all old windows, Greek, Roman, Byzantine, or Gothic, not indeed equally, but increasingly, as art improved. Only, in the Gothic, we measure not what is called a window, but what answers to *our* window, the interval between stone and stone, or what is called one "*light*." Moreover, under every kind of covering except groining, equable support to the roof or ceiling requires all these windows or "lights" to be equidistant. It was only in consequence of groining (which is the most perfect and costly kind of ceiling, and, unlike other kinds, concentrates its whole weight on a few widely separated points of support,)

that this equidistance of the windows or lights was disturbed, by collecting them into *groups*, such as we see in the Temple of Peace, and the hall of Diocletian's baths, but never afterwards till the revival of groining, in the eleventh century. This revival of groining was the origin of the whole Gothic system, leading directly or indirectly to all the peculiarities of that system, now copied like "Hamlet with Hamlet's part omitted." Thus the groining alone induced this grouping of lights together, at first in twos or threes, and then with circle or rose perforations between their arched heads, wherever there was room; till at length, this treatment pushed to the utmost, with as much perforation and attenuation of the separating masses as possible, produced what we call a *tracery window*. But where there was no groining, there were none of the things distinctive of Gothic building, (at least none before the age of affectation and sham art began)—no buttresses, no pinnacles, and no tracery windows; but the lights remained single and equidistant, even to the times of the most complete Gothic, as may be seen in the nave of St. Albans. The deservedly popular author of the "Stones of Venice" is therefore wrong in regarding a tracery window as *one* aperture, and the tracery as "aperture-filling." It is not one aperture *subdivided* to support the glazing, but several apertures *collected* into a group; there being no assignable motive for making any single window aperture so wide as not to support its glazing without subdivision; and again, no motive

(except apish imitation of human work) for this grouping of apertures, except under a groined ceiling. The Gothic fenestration and tracery, then, is a beauty belonging of right to those only who can afford the Gothic groining. In buildings with any less noble covering, it is a *stolen* beauty, an unearned lion's skin, an apish substitute for design. Its beauty was the first snare that led to this fallacy in architecture — the first thing they began (in the modern world) to steal. The Ducal Palace at Venice is, no doubt, in most of its design, very noble by comparison with anything cotemporary or later in England; but its upper windows are of this fallacious kind,—they are imitations of human work as ornament,—they are only mimic church-windows, used, just as we and our ancestors of the Tudor times have used them, to save the trouble of designing anew for new circumstances.

In domestic buildings, then, we have every reason for equidistant, and none for grouped lights;—every reason for increasing their number, and none for increasing their width;—and no more reason now than in the middle ages for making any light wide enough to need subdivision by upright bars; the wooden bars of our present sashes being merely the last attenuated remnant of the mullions of mimic church-windows, easily traced from such examples as the Ducal Palace, through such as Windsor Castle, Hampton Court, and the wooden Elizabethan windows, down, by a continual diminution, to the last most approved "ovolo bar." Cleansed of this

trash, and reduced to a rational unaffected width, our windows would re-assume graceful proportions, a height of above twice their width in low rooms, and in principal ones thrice or more. This, with their increased number and closeness, would alone almost make them, if equidistantly placed, ornaments to the exterior, instead of wounds and blots (always provided we avoid the irrational deformity, now common in London, of making an angular pier the narrowest, instead of the widest). But this is not all:—the number of openings being no longer restricted, there is no reason for getting the utmost light from each, and therefore no reason for a square top fitting the ceiling;—all imitations of antiquated or infant art (as of straight coverings, after the invention of the arch, for instance,) being barbarous and apish. The forms proper for window-arches are the semicircular, the segmental (of not less than a quadrant), the pointed in any proportion lower than equilateral, the segmental pointed, (or castle arch,) the three-centred and four-centred pointed (each in any proportion lower than equilateral), and the round or pointed trefoil arch; all except the two last being producible with one, or at most two, wedge-shaped bricks, without cutting, except to accommodate their tops to the courses of the wall. Thus we have plenty of scope for more variety than those spurning utilitarian fetters seem ever to have developed. For attic or mezzanine windows, too, or any that are limited to a height little or no more than their width, the rational shapes are *not the square*, but the circle, "vesica

piscis," outcurved triangle, and outcurved lozenge, all producible with one wedge-brick. Sharply pointed arches are not proper except where a pillar or other weight stands on their vertex; and ogee arches never.

Again, the arch-bricks could never, unless for some affectation, have their front edge square, but always truncated, or "*chamfered*," to admit more light; if not so modified as to produce some repeated edge ornament round the arch;—and this would always be more marked or rich than any of the same kind that might be applied to the straight sides or "*jambs*" below, because they are less important,—a brick out of them could be better spared than out of the arch. Hence a necessity, whether the jams were moulded or not, for some horizontal member, or "*impost*," to separate the simpler kind of finish from the richer; and where the windows were near together, this would best be continued all across the intermediate pier, serving as a *capital*, to connect and identify it as one pillar; and in that case, it should also have its own *base*, standing on a continuation of the window-sills, or on some lower string-course.*

Dry steening is brickwork laid dry round wells, to keep the ground from falling in.

Flat joint pointing is when the mortar in the joints is well raked out and filled in again with blue

* The St. Martin's Schools, Castle-street, Long Acre, being an evident attempt towards rationalism in brickwork, will partly illustrate some of the above changes.

mortar, and the courses are marked with the edge of the trowel.

Tuck and pat pointing is when, in addition to the above, plaster is inserted in the joints, with a regular projection, and neatly pared to a parallel width.

Outside splays, as cut and rubbed to shew fair. See Plate 1, fig. Q.

Inside splays, only rough cut to batten or plaster against. See Plate 1, fig. P.

MEASUREMENT OF BRICKWORK AND EXCAVATION.

The standard measure for brickwork in London is the rod of 16 f. 6 in. square, which dimension being multiplied into itself produces 272 f. 3 in., but the odd 3 inches are never taken into account. It is therefore always considered as 272 superficial feet, at $1\frac{1}{2}$ brick, or $13\frac{1}{2}$ inches thick, or 306 feet cube, viz.: 272 f. by 1 f. $1\frac{1}{2}$ in. All the other thicknesses are reduced to this standard, as shewn hereafter in the manner of taking the dimensions and abstracting the work.

In measuring bricklayers' work, it is usual to begin by taking the excavations; first, for the basement story, if any, which is stated as digging and throwing out or wheeling away; the ground for sunk stories, according to circumstances; next, the excavations for footings to walls.

It is customary, in taking the digging to footings of walls, to allow about six inches on each side, over and above the thickness of the walls, for room to

work them; but if they are deep, and the ground bad and loose, allow nine inches on each side on account of its falling in. But in sunk stories only allow to the extent of the footings, except in very loose ground.

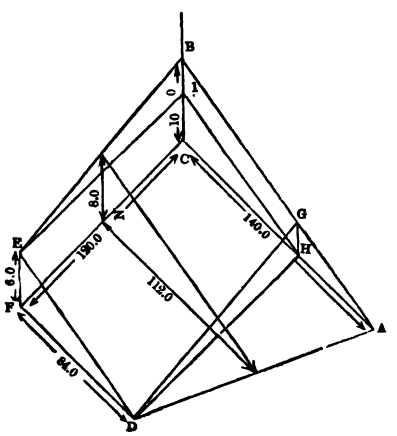
In taking the dimensions, the length, depth, and width must be measured as before described, and reduced to the yard cube of 27 feet, viz.: 3 f. by 3 f. by 3 f.

Claying of vaults, by the yard square of 9 feet, describing the thickness, 3 f. by 3 f.

In measuring digging in sideling ground, where the areas of the two ends of the excavation are unequal, the cubic content must be found by the following rule:—

Multiply the sum of the extreme areas, plus four times the middle area, by one-sixth of the length, and the product will be the answer required.

EXAMPLE.—To find the cubic content of the excavation A B C D E F for the sunk stories of a house, to be built on the side of a hill:—



$$\frac{140\times10}{2} = 700$$

$$\frac{84\times6}{2} = 252$$

952 sum of extreme areas.

$$\frac{112\times8}{2} = 1792$$ four times middle area.

2744

120 length.

54880

2744

6)329280

27) 54880 (2032 yards 16 feet.

54

88

81

70

54

16

As an illustration of the correctness of the rule, let us take the same example on a different principle of measurement. The solid A B C D E F may be divided into the two prisms G H I B E D and E F C I H D and the pyramid D A H G. Taking each of these separately, we have—

Prism G H I B E D $= \frac{84\times4\times120}{2} = 20160$

Prism E F C I H D $= \frac{120\times6\times84}{2} = 30240$

Pyramid D A H G $= \frac{56\times4}{2}\times\frac{120}{3} = 4480$

Total... 54880 cubic ft.

or 2032 yards 16 feet, as before.

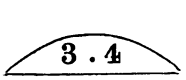
In measuring brickwork always begin with the foundations, then proceed with measuring each story separate (or as high as the wall continues of the same thickness), as solid work, according to their respective thicknesses; then add for all projections, as breasts of chimneys, &c., deducting the openings, but not the flues, as the extra trouble and the pargetting is deemed equivalent to the deficiency of materials; but deduct the openings of doors, windows, &c.

If the house or building be rectangular, measure two walls the whole length of the external face, and the other two internally, so as to get the true cubical contents.

But in measuring for labour only, the external face of the work is girt, and multiplied into the height and thickness, to pay for the extra labour of plumbing the angles, and working the returns fair.

In measuring walls that are faced with superior bricks, the walls are first measured as common work, and then the superficial quantity of facing is taken, as hereafter shewn, and is valued by considering the facing as two thirds of a brick thick, and deducting the common brickwork from the price thereof, the same thickness, viz., two thirds of a brick; by which the value per foot superficial is ascertained.

In measuring circles, or semicircles, they are marked accordingly in the measuring-book. Thus:



or

with the diameters figured.

To measure angle chimneys, draw lines on the floor, parallel to the two sides of the room, cutting the parts intersected by the chimney, as shewn in the plans, Plate 1; take either side by the height of the floor, and half the other (the work forming a triangle) for the thickness, either as the number of bricks, or as cube work, which, by the directions before given, and the example shewn in the first chimney taken, proves it to be exactly the same: consequently, if the projection should not amount to any certain number of half-bricks, it would be best to take it as a cube dimension. In all cases it is supposed that the walls, as shewn by the dotted lines, are measured before the projecting chimneys are taken, which is the usual custom.

In taking the dimensions of vaults, measure the abutments, or side walls, to the springing of the arch, then bend your rods round the soffit of the arch; and add once and a half the thickness thereof, by which you obtain the average girt of the arch; then take the length clear of the walls; but if the arch is turned over one or both walls, add the thickness thereof to the length of the arch. But in taking the height of the walls, measure to the crown of the arch, without making any deduction for the declivity of the arches, on account of the additional trouble and waste of bricks, in cutting and fitting them to the curved soffit of the arch. Likewise, in deducting openings with circular heads, the dimensions should only be taken to the springing of the arches, on

account of the trouble and waste of bricks in fitting them to the arches.

Drains to be taken and reduced as common brickwork if built with mortar.

Shafts of chimneys are measured as solid work.

Ovens and coppers are measured as solid cube brickwork, deducting the ash-holes only.* Tiles, Welsh lumps, and fire bricks, are to be allowed as extras.

In these, or any other brickwork that it is considered best or most convenient to measure by the cubic foot, multiply the solidity by 8, the number of $1\frac{1}{2}$ inches in a foot, and divide it by 9, the number of $1\frac{1}{2}$ inches in $13\frac{1}{2}$ inches, which will reduce it to the standard of $1\frac{1}{2}$ brick, or $13\frac{1}{2}$ inches in thickness.

In measuring brickwork no allowance is to be made in quantity for small or difficult works. Timbers inserted in the walls are not to be deducted. When plates are bedded in the walls, two inches to be allowed for ditto where no brickwork is over them. All sills and stone strings are measured in.

All cuttings to be measured superficial; as outside splays, cut and rubbed to shew fair, or inside ditto rough cut for battens, &c. See Plate 1, figs. P. and Q.

Birds' mouths at per foot run, being notched to fit. See Plate 1, fig. O.

* This method is in common use amongst surveyors; but it would be far more consistent to measure the actual quantity of brickwork, allowing for the extra labour in price.—Ed.

Facings of all descriptions to be measured extra by the foot superficial; in which case the reveals are also measured, except where intended to be stuccoed.

Gauged arches to doors, windows, &c., are also measured by the foot superficial.

Groins are measured as common work, only taking the run of cut groins at per foot.

Bricknogging, by the yard square of 9 feet, including the timbers.

Brick paving, ditto, ditto.

Facias, beads and quirks, dentil or plain cornices, &c., measured and valued by the foot run.

TILING.

TECHNICAL TERMS AND REMARKS.

Eaves are the lower horizontal edges of the tiling. They are called *dripping* eaves when they overhang the walls.

Hips are the inclined ridges, like those of a pyramid, formed by the meeting of two tiled surfaces rising from two walls that form a salient angle.

Valleys are the reverse of hips, being the inclined furrows, like those of a hollow inverted pyramid, formed by the meeting of two roof-faces over a re-entering angle of the plan. Wherever there is a re-entering angle, a valley is unavoidable, while a hip can occur only over a salient angle. But hips

are in no case necessary, since the roof-planes rising from two parallel walls may be continued till they meet a third wall, raised into a triangle or *gable* for this purpose.

Hence this simplest kind of roof is called a *gabled*, in contradistinction to a *hipped* roof. It is obvious that, on the same area and with the same inclination, both kinds must have just the same superficial quantity of covering; and thus the gables or triangles of wall are wholly extras. Against this must be set greater simplicity and economy in the internal framing of gabled than of hipped roofs.

In every complete system of tiling, tiles of three forms must be provided, viz. for continuous surfaces, for ridges, and for valleys; a fourth being needed for hips, where hips are used. But in England, by the use of mortar as a lute to their joints, we commonly make shift to do with one kind for ridges, hips, and (in a reversed position) for valleys. As the legitimate object of tiling, however, is to exclude water, *without any dependence on lutes or cements*, all refined or artificial kinds, as the Grecian and modern Italian, are contrived to have no joint through which water can enter *without ascending*. In these (which we may distinguish as *independent tilings*), two forms of surface-tile are commonly used, the principal ones having their lateral edges raised or turned up, and two of these edges together being covered by a smaller tile like a half-tube. The Chinese effect the same by half-cylinders, all alike, but alternately reversed, a row with their hollows up-

ward being covered by a row with their hollows downward.

Pan tiles have a section like so as to serve in some measure like two of the Chinese made in one piece, or one of the Italian tiles with its small joint-tile on one side attached. We make no attempt, however, to extend the principle of independent tiling to the hips and ridges.

Plane tiles attempt no mechanical exclusion at all, but only act either by the interposed cement, or by a slope so rapid as to conduct away the water before it has *time* to penetrate; *i. e.* simply on the principle of thatch. They are quite as heavy as any other kind, if we take into account the greater slope and consequent quantity of roof-framing required.

"*Fancy*" or "*Ornamental*" *plane* tiling, are terms applied to any whose lower edges terminate otherwise than by a horizontal line; though in fact it is this horizontal edge which is *fanciful* (*i. e.* sacrifices utilitarian ends to a matter of taste or fancy); for the mere problem, how best to exclude water and throw it off quickly, forbids any horizontal dripping edges, (which allow water to hang along their whole length, instead of collecting it to a point,) and equally forbids any joints in the direct line of descent, (unless they have raised margins, and are covered in some such way as the Greek, Italian, Chinese, or pan tiles,) as they afford an ingress without an ascent. Hence, only *diagonal* edges would be found in plane tiles really *plain* or rational; and the term

fancy tile applies not to these, but only to the horizontal-edged ones now in common use among us.

Diagonal-edged or lozenge tiling has indeed the advantage in every respect. Thus if the angles of the tile and inclination of the roof be properly adjusted, it will fit the hips and valleys without any cutting; and for fitting the horizontal ridges, half-tiles may be made. Again, it is the only form which admits of being made independent without two varieties of surface-tiles; for if the two upper edges of each lozenge-tile have flanges turned up, and the two lower edges similar flanges turned down, every joint will be protected as perfectly as in Italian tiling; and one hip-tile of a trumpet or bell-flower shape, the ordinary valley-tile, and ridge-tiles move like saddles, alternately convex and concave, to protect each other, would render the whole system complete.

The "*filletting*" of cement over our tiling, where it meets a wall higher than itself, must, like all other dependence on luting to keep out weather, be esteemed a barbarism of the most inartificial kind, and should be replaced by tiles of a proper shape, built into the wall.

Measurement.—Plane and pan tiling to be measured by the square of 100 feet.

In measuring plane tiling—

Allow for the eaves 4 inches extra.

Ditto for dripping do. 6 inches extra.

Ditto for all cuttings, hips, &c., 3 inches extra.

Ditto for valleys, 12 inches extra.

In measuring pan tiling—

Allow for the barge per foot run.

Ditto for heading to barge per foot run.

Ditto for cutting to hips and splays per foot run.

Ditto for hips and ridges per foot run.

Number the hip hooks, which should be painted three times in oil.

Ditto T nails, ditto.

Deduct for chimneys, and deduct and add for dormers.

If the roofs are hipped, take the length at the bottom of the sides, and not measure the end; the two side triangles being equal to the hipped end one.

In order to illustrate the principle of measuring bricklayers' and tilers' work, and bringing it into bill, in Plate 1 is given a plan, elevation, and section of the front wall of a house, with the windows to a larger scale, and also plans of different chimneys. The rules before stated are likewise explained, by shewing the manner of taking the dimensions in the measuring-book, and the method of preparing the abstract, and entering them therein, together with other imaginary quantities, to make the particular manner of abstracting the work perfectly clear and explicit.

See the general rules under the head Measuring, viz :—

BRICKLAYERS' WORK done for A. B., Esq., at his house, Kensington,

By C. D.

Measured January 1st, 1843, with Mr. E. F.

ft.	in.	bks.	ft.	in.		ft.	in.	
						26	0	front of house.
27	6	5	13	9	Brick footing, 2 bottom courses.	0	9	projec. of footings.
0	6					0	9	do. other end.
					27 6 Figs. C and K.	27	6	
26	9	4	20	1	Do. average thickness of the courses above do.	26	0	
0	9					0	9	½ B. at each end.
					80 4	26	9	
26	0	3	234	0	B. W. above do. to under side of ground floor.	0	6	under floor.
9	0					8	6	height of story.
					468 0	9	0	
2) 5	0	½	35	0	DDt. openings 17 6	5	0	
3	6					0	4½	upper reveal.
2) 5	4½	2½	45	8	DDt. reveals	5	4½	
4	3					3	6	
						0	9	2 side reveals.
2) 4	3	2	29	9	DDt. backs 59 6	4	3	
					Windows.			
7	6	½	26	3	DDt. openings 13 2			
3	6							
7	10½	2½	33	5	DDt. reveal			
4	3				Door.			
26	0	2½	338	0	Add B. W. to ground floor.	1	0	thickness of floor.
13	0					12	0	height of room to under side of one-pair floor.
						13	0	
2) 7	6	½	52	6	DDt. openings 17 6			
3	6							
2) 7	10½	2	66	11	DDt. reveals 133 10			
4	3							
2) 4	3	1½	21	3	DDt. backs.			
2	6				Windows.			

ft.	in.	bks.	ft.	in.	
10	0				DD^{t}. opening
3	6	½	35	0	17 6 } Front door.
10	4½				DD^{t}. reveal
4	3	2	44	1	88 2
26	0				Add B. W. to one-pair floor.
13	0	2	338	0	676 0
3) 8	0				DD^{t}. openings
3	6	½	84	0	28 0
3) 8	4½				DD^{t}. reveals } Windows.
4	3	1½	106	9	
3) 4	3				DD^{t}. backs
2	3	1	28	8	
26	0				Two-pair floor, B. W. to under side of tie-beam.
9	11	1½	257	10	
3) 5	6				DD^{t}. opening
3	6	½	57	9	19 3
3) 5	10½				DD^{t}. reveal } Windows.
4	3	1	74	11	
3) 4	3				DD^{t}. backs
2	9	½	35	1	17 7
26	0				Add B. W. to parapet to underside of coping.
3	2	1	82	4	
					In making deductions for revealed windows, if the wall is only one brick thick, take one reveal in and one out, as follows:
5	8¼				DD^{t}. upper windows, suppose wall only 1 brick, and the window openings of the annexed dimensions . . . . .
3	10½	1	22	0	5.6 / 3.6

ft.	in.	
1	0	thickness of floor.
12	0	height of room.
13	0	

MEASURING CHIMNEYS.

The height of the rooms supposed to be 10 feet.
Do. of the chimney-openings, 4 feet.

(See Plate No. 1.)

ft.	in.	bks.	ft.	in.	
10	0				
4	6	3	45	0	B. W. to angle chimney.
			90	0	
4	0				
3	6	2	14	0	DD^{t}. opening.
			28	0	
10	0				
4	6				
2	3		101	3	Cube B. W. to angle chimney. I.
10	0				
9	0	3	90	0	B. W. to angle chimney. L.
			180	0	
4	0				
3	6	2	14	0	D.D$_{t}$. opening.
			28	0	
10	0				
5	6	1	55	0	B.W. to chimney-breast. M.
4	0				
3	6	2	14	0	DD^{t}. opening.
			28	0	
10	0				
4	9	5	47	6	B. W. to angle chimney. N.
			95	0	
10	0				
4	0	2	40	0	DD^{t}. B. W. angle.
4	0				
3	6	2	14	0	DD^{t}. opening.
			108	0	
			54	0	

ft.	in.	
101	3	This, though taken before, is entered again to shew the manner of abstracting cube B. W.
	8	
9) 8	0	
90	0	red. to $1\frac{1}{2}$ br. th.

All gauged work is first measured in with the common brickwork, and afterwards taken at per foot superf. measured as follows:

3	6			
0	4	1	2	soffit to gauged arches.
3	10			
1	0	3	10	face of ditto.

(See Plate 1, fig. G.)

ON ABSTRACTING.

In abstracting bricklayers' work, although it will be found advantageous, it is not so absolutely requisite to observe a regular rotation as in joiners' work. But particular attention is required in abstracting bricklayers' work, to place the contents of the dimensions, according to their different thicknesses, and the deductions thereon, so that they may be reduced to the proper standard or thickness (of one brick and a half or thirteen and a half inches) in the abstract; which will be perfectly easy after considering the explanation given, and seeing the form of the following abstract:—

Place the cube brickwork in the first columns	One column for one brick thick.	Add.
	One do. for one and a half do.	
	One do. for one brick thick.	DD.
	One do. for one and a half do.	

By which method you may abstract brickwork to any thickness. Thus:—

If half a brick thick, one half the quantity may be placed under the head of one brick, or one-third the quantity, under the head of 1½ brick.

If two bricks in thickness, twice the quantity may be placed under the head of one brick.

If two and a half bricks in thickness, the same quantity must be placed under the head of one brick and also under 1½ brick.

If three bricks in thickness, twice the quantity must be placed under the head of 1½ brick.

In this manner brick walls of all thicknesses may be abstracted under two heads, and thereby avoid having a column for every thickness of wall in the building.

Next proceed with the different descriptions of tilings, and all other work measured by the square of 100 feet.

Next, the pavings, bricknogging, and other work measured by the yard square of nine feet.

Next the work measured by the foot superficial; and next with the work measured by the foot run; as shewn in the following abstract.

The following are imaginary dimensions, to explain the manner in which walls of any number of bricks in thickness may be abstracted under the two heads of one brick and one brick and a half. These being the general thicknesses of walls, it very seldom occurs that the walls are of the thicknesses here stated, which are only given to make the principle understood.

ft.	in.	bks.	ft.	in.	To be abstracted as ft.	in.		bks.
5	6							
2	3	½	12	4	6	2	.	1
7	6							
5	8	1	42	6	42	6	.	1
10	3							
6	9	1½	69	2	69	2	.	1
8	6							
6	2	2	52	5	104	10	.	1
0	0				45	0	.	1½
4	6	2½	45	0	45	0	.	1
9	0							
5	3	3	47	3	94	6	.	1½

ft.	in.	bks.	ft.	in.	To be abstracted as ft.	in.		bks.
8	0				50	8	.	1½
6	4	3½	50	8	101	4	.	1
7	6							
3	9	4	28	1	112	4	.	1
12	6							
3	8	4½	45	10	137	6	.	1½
10	6							
5	2	5	54	3	271	3	.	1
8	4				31	3	.	1½
3	9	5½	31	3	125	0	.	1
10	10							
5	6	6	59	7	238	4	.	1½

Abstract arranged as before stated.

ABSTRACT OF BRICKLAYERS' WORK done for A. B. by X. Y.
Abstracted with Z. January 1st, 1843.

RODS.							SQUARES.		YARDS.			FEET.			Nos.
Cube B. W.		Superficial B. W.					Tiling.		Paving.						
Add.	DDt.	Add.		DDt.											
		1 Bk.	1½ Bk.	1 Bk.	1½ Bk.		Plain.	Pan.	Grey Stock.	Dutch Clinkers.	Brick-nogging.	Super.		Runs.	
ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.										
101 3		27 6	27 6	17 6	45 8										
		80 4	468 0	45 8	33 5										
		338 0	338 0	59 6	17 6										
		676 0	257 10	13 2	21 3										
		82 4	90 0	33 5	28 0										
		55 0	180 0	133 10	106 9				Common Bricks.	10 inch Tiles.					
		95 0	95 0	17 6	19 3										
		6 2	69 2	88 2											
		42 6	45 0	28 8											
		104 10	94 6	74 11											
		45 0	50 8	17 7											
		101 4	137 6	28 0											
		112 4	31 3	28 0											
		271 3	238 4	28 0						12 inch Tiles.					
		125 0		108 0											
These columns are to be added up, subtracting the deductions from the additions, and the remainder is to be reduced to the standard thickness of 1½ brick, and brought into rods of 272 ft. 3 in. superficial.															

If different sorts of bricks are used, separate heads must be formed in the abstract, each detailing the various proportions and descriptions of the work

ROTATION

To be attended to in bringing the quantities into Bill.

BRICKLAYER.

Yds.	ft.	in.		
			Cube of digging according to description, viz., throwing out, basketing, wheeling, or carting away, according to the distance	
			Cube of concrete to foundation, or otherwise	
Rods	ft.	in.		
			Reduced brickwork, if stock bricks, if part with other bricks, their proportions, &c.	
			Do. do. to garden walls . .	
			Or whatever way the work may be done at per rod.	
Sqres.	ft.	in.		
			Pan tiling, if dry or pointed inside or out	
			Plain tiling, if double fir laths and wrought nails, &c. .	
			Or other articles by the square.	
Yds.	ft.	in.		
			Bricknogging, flat or on edge	
			Brick paving, do. . .	
			10 in. or 12 in. tile paving .	
			Pebble paving	
			Or other articles by the yard superf.	

ft.	in.				
		Superf. of gauged arches .			
		Malm facings, either as best or second			
		And other articles at per foot superf.			
		Run of cut splays or birds' mouth, &c.			
		And all other articles at per foot run, and then the articles numbered, as chimney-pots, hip-hooks, &c. &c.			

VALUATION OF BRICKLAYERS' WORK.

CALCULATION OF MATERIALS.

Digger.—27 cubic feet, or one cubic yard, is called a single load, and contains 21 striked bushels. Two cubic yards = one double load.

In estimating the cubic content of excavation required to form a given amount of embankment, due regard must be paid to the nature of the soil of which the embankment is to be formed.

The following may be safely taken as average rates of the alteration in bulk of various soils when excavated and carried into embankment.

Clays.—*Compression* about one-tenth of the original bulk in excavation.

Gravels.—*Compression* about one-twelfth of the original bulk in excavation.

Sand occupies the same space in bank as in excavation.

Chalk.—Slight increase of the original bulk in excavation, proportionate to the size and hardness of the fragments.

Rock.—Increase about one-half of the original bulk in excavation, according to the size of the fragments.

23½	cubic feet of	sand	weigh one ton.
21¾	do.	gravel	do.
17	do.	clay	do.
13	do.	chalk	do.
18	do.	night-soil	do.

Night-soil is removed in carts containing 45 cubic feet, or 2½ tons.

Concrete is made of ground stone lime, and sharp gravel, with a proper proportion of sand, mixed in the proportion of five or six parts of gravel to one of lime, according to the nature of the lime and the proportion of sand mixed with the gravel. Its quality is much improved by the addition of smiths' ashes, or any material containing iron; and for this reason ferruginous gravel is to be preferred whenever it can be obtained.

A cubic yard of concrete, containing 27 cubic feet when mixed, requires 34 cubic feet of gravel, sand, and lime. Therefore, at the proportion of six of gravel to one of lime, a cubic yard of concrete will require 1.1 cubic yard of gravel and sand, and three bushels of lime.

Concrete expands slightly in slaking; but this expansion is too trifling to be taken into account in framing an estimate.

SIZE AND WEIGHT OF VARIOUS ARTICLES.

	Length.		Breadth.		Thickness.		Weight.	
	ft.	in	ft.	in.	ft.	in.	lbs.	oz.
Stock bricks . . . each .	0	8¾	0	4¼	0	2½	5	0
Paving do. . . . do. .	0	9	0	4½	0	1½	4	0
Dutch clinkers . . do. .	0	6½	0	3	0	1⅓	1	8
12-inch paving tiles . . do. .	0	11¾	0	11¾	0	1½	13	0
10-inch do. . . do. .	0	9¾	0	9¾	0	1	8	9
Pan tiles . . . . do. .	1	1½	0	9⅞	0	0½	5	4
Plain tiles . . . do. .	0	10½	0	6⅝	0	0⅝	2	5
Pantile laths, per 10 ft. bundle . .	120	0	0	1½	0	1	4	6
Ditto, per 12 ft. bundle . . .	144	0	0	1½	0	1	5	0
A bundle contains 12 laths.								
Plain tile laths, per bundle . .	500	0	0	1	0	0¼	3	0
Thirty bundles of laths make a load.								

A bricklayer's hod measures 1 ft. 4 in. × 9 in. × 9 in., and contains 20 bricks.

A single load of sand is 27 cubic feet, or one cubic yard.

A double load of sand is 54 cubic feet, or two cubic yards.

A measure of lime is 27 cubic feet, or one cubic yard, and contains from 16 to 18 bushels.

QUANTITIES, ETC.

A rod of brickwork measures 16 ft. 6 in. × 16 ft. 6 in., or 272 ft. 3 in. superf., 1½ brick or 13½ inches thick, called the standard thickness, or 306 cubic feet, or 11⅓ cubic yards.

A rod of brickwork laid to a 12-inch gauge, *i.e.* four courses to measure one foot in height, requires 4353 stock bricks.

Ditto, laid to 11½-inch gauge, requires 4533 stock bricks.

A foot of reduced brickwork requires 16 bricks.

These calculations are made without allowance for waste; and indeed there is very little, as nearly every part is worked in, and much space is occupied by timbers, flues, &c., for which no deduction is made in measurement; and therefore in the erection of dwelling-houses containing flues and bond timbers, 4300 stocks is quite sufficient, and this is the usual number allowed for a rod of brickwork.

5370 stocks to the rod, if laid dry.

4900 do. in wells and circular cesspools.

A rod of brickwork, laid four courses to gauge 12 inches, contains 235 ft. cube of bricks, and 71 ft. cube of mortar; and the average weight is about 15 tons.

A rod of brickwork requires 1½ cubic yard of chalk lime and three loads of sand; or one cubic yard of stone lime, and 3½ loads of sand; or 36 bushels of cement, and 36 bushels of sharp sand.

A cubic yard or load of mortar requires nine bushels of lime and one load of sand.

The proportion of mortar or cement, when made up, to the materials in their mixed state, is as two to three.

Facing requires 7 bricks per foot superficial.

Gauged arches 10 do. do.

Bricknogging per yard superficial, requires 30 bricks on edge, or 45 laid flat.

PAVING.

Description.		Number required.
Stock bricks, laid flat	per yard	36
Do. on edge	do.	52
Paving bricks, laid flat	do.	36
Do. on edge	do.	82
Dutch clinkers . . do.	do.	140
12-inch paving tiles	do.	9
10-inch do.	do.	13

TILING.

	Gauge.	Number required.
	inches.	
Pan tiles, per square	12	150
Do. . . do.	11	164
Do. . . do.	10	180
A square of pan tiling requires one bundle of laths and $1\frac{1}{4}$ hundred of 6*d.* nails.		
Plain tiles, per square	4	600
Do. . . do.	$3\frac{1}{2}$	700
Do. . . do.	3	800
Do. . . do.	laid flat	210
A square of plain tiling requires one bundle of laths and nails, one peck of tile pins, and three hods of mortar.		

CALCULATION OF LABOUR.

Digger.—The amount of digging which a man can perform in a day depends so much on the nature of the soil on which he has to operate, that it is almost impossible to fix a constant for this description of labour: the following data may, however, serve as a slight guide.

In loose ground a man will throw up about ten

cubic yards per day; but in hard or gravelly soils, where *hacking* is necessary, from three to five cubic yards, according to the hardness of the ground, will be a fair day's work.

Wheeling is estimated by the run of 20 yards. A gang of three men, two for filling and one for wheeling, will remove about 30 yards per day to this distance; and the labour of removing earth may be calculated according to distance, allowing three men to the first run, and an additional man for every twenty yards of distance.

The following table, although far from complete, contains constants for all the principal descriptions of bricklayers' work.

		Constant. To be multiplied by the rate of wages for a labourer per day.
Concrete.—Labour in mixing, wheeling, throwing in from a stage, and puddling (where required to be done), including erection of scaffolding, per yard cube		.335
		To be multiplied by the rate of wages for a bricklayer and labourer per day.
Brickwork, per rod		4.941
		To be multiplied by the rate of wages for a bricklayer per day.
Extra labour to malm facings		.014
Paving.		To be multiplied by the rate of wages for a bricklayer and labourer per day.
Brick paving laid flat in sand	per yard	.046
Do. laid on edge in sand	do.	.075
Do. laid flat in mortar	do.	.056
Do. laid on edge in mortar	do.	.084
Paving-brick paving laid flat in sand	do.	.046

Paving-brick paving laid on edge in sand,	per yard	.106
Do. laid flat in mortar . .	do. .	.075
Do. on edge in mortar . .	do. .	.121
Clinker paving on edge in sand .	do. .	.132
10 or 12 inch tile paving . .	do. .	.010

Tiling.

Pan tiling laid dry . .	per square	.422
Do. pointed outside . . .	do. .	.685
Do. pointed inside and outside .	do. .	.790
Plain tiling laid to a 4-inch gauge .	do. .	.739
Do. . . to a 3½-inch gauge	do. .	.764
Do. . . to a 3-inch gauge .	do. .	.790

It would be impossible to give examples for every case that might occur; but the following will shew the method of valuing the principal descriptions of bricklayers' work.

Ex. 1.—To find the value of a cubic yard of concrete, made in the proportion of six parts of gravel to one of lime.

	£	s.	d.
1.1 yard of gravel, at per yard, prime cost .			
Carriage of above to the works . . .			
Three bushels of lime, at per bushel . .			
—— per cent. profit			
Labour on the above, found by multiplying the rate of wages per day for a labourer by the decimal .335			
Value per cubic yard . . . £			

Ex. 2.—To find the value of a rod of brickwork.

	£	s.	d.
4300 stocks, at per thousand . . .			
1½ yards of lime, at per yard . . .			
Three loads of sand, at per load . . .			
—— per cent. profit			
Scaffolding			
Labour per rod, found by multiplying the rate of wages per day for a bricklayer and labourer by the decimal 4.941			
Value per rod . . . . . £			

Ex. 3.—To find the value of a foot of malm facing.

	£	s.	d.
No. 7 best malms, (or seconds, as the case may be,) at —— each			
DD^{t}. the value of seven bricks, according to the quality with which the walls are built, the facing having been measured with the wall —— at —— each			
Extra value of the malm bricks			
Extra labour on the malm bricks, found by multiplying the rate of wages per day for a bricklayer by the decimal .014			
£			

Ex. 4.—To find the value of a yard of paving,—say with stock bricks laid flat in sand.

	£	s.	d.
36 stocks, at —— each			
Sand			
—— per cent. profit			
Labour, found by multiplying the rate of wages for a bricklayer and labourer by the decimal .046 .			
Per yard . . . . . £			

Ex. 5.—To find the value of a square of plain tiling, laid to a four-inch gauge.

	£	s.	d.
600 plain tiles, at per thousand . . .			
One bundle of laths and nails . . .			
One peck of tile pins			
Three hods of mortar			
—— per cent. profit			
Labour, found by multiplying the rate of wages for a bricklayer and labourer per day by the decimal .739			
Per square . . . . . £			

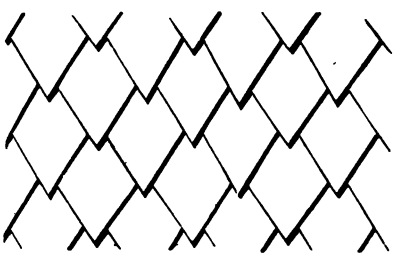
SLATER.

The properties of slate, easy lamination and remarkable transverse strength at small thicknesses, render it a question whether it were not rather designed for man's use as a *flooring* material, to span

the intervals of joists (or incombustible substitutes for joists), than for roof coverings. When used for the latter, the impossibility of giving it the property of independent tiling (as the Greeks did their *marble* slates, by working them with ledges,) must render it always, like plane tiles, a mere mineral thatching; and hence it is the most inartificial and least improvable of all coverings; while its thinness also renders it the least sightly, from the want of relief and shadow.

What we observed of plane tiles, that their most plain and rational position — that best answering their material ends—was diagonal or scalewise, applies equally to slates; and hence such arrangements are most absurdly called "fancy" slating; that in common use being really the most fanciful.

Fig. 6.



Slating is measured superficial, and charged per square of 100 feet.

In measuring, allow for the eaves whatever the bottom course measures, and for the hips and valleys measure their length by 12 inches, viz., six inches on each side; also the length of all irregular angles, as chimneys, dormers, &c., by six inches wide, as a fair allowance for cutting and waste.

For circular slating allow one-third extra.

VALUATION OF SLATERS' WORK.—TABLE OF MATERIALS AND LABOUR.

Average sizes of Slates.	Average gauge when laid.	1200 will cover squares.	Weight per thousand of 1200 in tons.	Number required to cover one square.	Nails required to a square.		Constant.
					Iron, cast or wrought, at per hundred.	Copper, at per lb.	To be multiplied by the rate of wages for a slater per diem.
	ft. in. ft. in.	inches.				lbs.	
Doubles . . .	1 1 by 0 6	$5\frac{1}{2}$	$2\frac{1}{2}$	$\frac{3}{4}$	480	480	5	.173
Ladies	1 3 „ 0 8	7	$4\frac{1}{2}$	$1\frac{1}{4}$	280	280	3	.155
Countesses . .	1 8 „ 0 10	10	$7\frac{1}{2}$	2	160	320	$3\frac{3}{4}$	.137
Duchesses . . .	2 0 „ 1 0	11	10	3	127	254	$2\frac{3}{4}$	.119
Tavistock			$3\frac{1}{2}$					
			A ton will cover					
Imperials . . .	2 6 „ 2 0	....	$2\frac{1}{4}$ to $2\frac{1}{2}$					
Rags and Queens,	3 0 „ 2 0							
Westmorelands, various			$2\frac{1}{4}$					

Example.—To find the value of a square of duchess slating, copper nailed.

	£	s.	d.
No. 127. Duchesses, at per thousand . .			
$2\frac{3}{4}$ lbs. of copper nails, at per lb.			
—— per cent profit			
Labour on above, at per day			
Value per square . .	£		

CARPENTER AND JOINER.

TECHNICAL TERMS, AND REMARKS ON WOODWORK.

Of all the materials in a modern English building, the wood, however concealed or disguised, plays the most important part; for to this all others are referred for support, or as a remedy for their increasing decrepitude and failings. In domestic buildings, indeed, we have hardly ever, like some nations, advanced to the application of less perishable materials in the structural parts, or beyond mere space-filling; and have thus always been dependent on carpentry to a remarkable degree, and now entirely dependent on it, to the exclusion of arching and all scientific masonry. In public buildings this is far more remarkable than in private ones; for elsewhere only infant communities have allowed the woodwork to hold the same place and importance in these as in their dwellings; and every advance, up to the highest civilization, is marked by contrivances to substitute incombustible or less perishable materials in lieu of the ordinary carpentry, till (if not entirely superseded, as in the Memnonium, Pantheon, Milan Cathedral, or Redcliffe Church,) it is at least confined

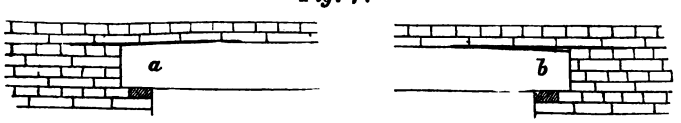
to the least essential parts—to such as may entirely perish without affecting the stability of the remainder, and be renewed without disturbing it; a law having obtained from the earliest and rudest times, in all except sham architecture, that wood should sustain only wood or light coverings, never masonry or masses of more permanent matter than itself, not even plaster. Hence all the styles of decorative architecture, or all those features which, from their beauty (the evidence of thought formerly concentrated on them), or from their mere association with splendid works, after-ages find it worth while to counterfeit, have (wherever masonry has been used at all) sprung from this kind of work, and not from carpentry. And thus it happens that when national poverty, or (what is far worse) decline and loss of honest soundness and accuracy in other workmanship, necessitates a general recourse to woodwork as the easiest substitute, this only presents (where seen at all) mimic representations of the forms of stone features, irrationally placed, combined, and distorted; so that the only difference between the building of infant and aged communities (both being equally dependent on carpentry and joinery as their main element) is, that in the former the woodwork is visible and rationally formed with a view to its actual functions, while in the latter it is all concealed, or disguised into shapes inexplicable, unless as scenic representations of better materials and work.

Sleepers, *bond-timber*, *plates*, and *lintels* have

been noticed under the head Brickwork; to which they properly belong, being substitutes for members not legitimately made of timber, except where the whole work is of that material, or is not building at all, but framing.

Breast-summers are a still more barbarous expedient of this kind, being a timber lintel on a greatly enlarged scale, substituted for an arch to support the whole *breast* or front wall of a building, over a shop-window or a cart-way. They have lately been made of cast iron; with what advantage, either in durability or resistance to fire, it is difficult to see. They have also, when of wood, been stiffened by *trussing*, *i.e.* sawing in halves lengthwise, and inserting two or three bars of oak, arranged as a flat arch, as deep as the beam will admit; and it seems strange that the immense disproportion thus displayed between the effective and non-effective parts of the materials should not have awakened their owners to the enormous waste entailed in the abandonment of the arch for these barbarous substitutes. To prevent the cracks usually caused in the wall above, by the shrinking of the breast-summer itself in depth, the late Mr. Bartholomew invented the following arrangement, which he called *boat-bridging*.

Fig. 7.



The ends of the timber being sloped off, a plate of wrought iron laid on them, and the whole super-

incumbent work laid to follow their slope, as at *a*; the shrinking, if correctly calculated, will be such as to let the iron plate sink, like a floating pier, (whence the name,) into the horizontal position shewn at *b*, and the courses of brickwork to settle evenly, though originally built out of level. As he conceived, however, "that the use of breast-summers is hardly honourable" (we should have said decidedly disgraceful, in any place pretending to civilization), "under any circumstances and under any form, and of any materials," he recommended the discarding them altogether for some such arrangement as this, viz. a very flat arch of common bricks, *a a*, between skewbacks of stone, and the whole built within and enclosed by two oblong welded hoops of wrought iron, of which one appears on

Fig. 8.

each face of the wall. The materials must be wedged so tight as completely to fill the hoops, and the cement must be of a kind that retains its original bulk, as Parker's. With the hoops preserved by pitch, this is nearly imperishable, and probably the cheapest arrangement for its purpose, practicable under the restrictions on brickmaking then in force.*

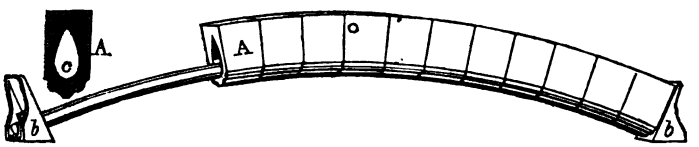
* Since the removal of these restrictions, however, not only is a greater economy of material attainable, but we should aim at burying the metal tie in the body of the work, out of reach of the air, and also at reducing it to the smallest possible quantity, and avoiding welding, in order that it may, in public works, admit of being made in copper. These conditions may be answered by a brick of the

Joists are the horizontal timbers laid across a room to support the floor of that above. As their strength increases with the square of their depth, but only with the simple breadth, a doubling of

---

form A, 4½ inches thick, from 4 to 6 broad on the unperforated face, 9 or 10 deep, and having the perforated faces converging to a point 12 or 13 feet distant (which is chosen for a reason to be explained presently). If an arch of these be built between two cast-iron skew-

Fig. 9.



backs *b b*, they may be confined by a curved tie of rolled iron, of the semi-tubular shape shewn in section at *c*, passing through all the arch-bricks, and through a hole in each skew-back, and keyed at the ends. As the arch is supposed to have the same radius in all works, whatever their span, these tie-bars could all be rolled between the same pair of unequal rollers, and cut to the required lengths. The lower edges of the arch-bricks may be formed to any kind of moulding or edge-ornament; and their thickness being 4½ inches, a wall of any thickness may be supported on two or more such arches placed in contact; or if so much strength be not required, they may be separated by any intervals capable of being spanned by the ordinary bricks of the wall above.

Such an arch, with a sectional area of about 40 square inches, 10½ inches deep, and a radius of 12 feet 6 inches, will, in brick of medium quality, bear (according to the received formulæ) about 8400 lbs. on each square foot of its upper surface, and be restrained from spreading by a tie of wrought iron of 0.7 inch sectional area. This is the *breaking* strain, or may be taken as *three times* the practical strength, or greatest weight to be trusted on it. If necessary, any greater strength may be obtained by turning a common brick arch, of any depth, on the backs of these, having taken care to increase the sectional area of the tie in the same proportion that the whole depth or strength is increased.

their depth produces the same effect as quadrupling their breadth. Hence the advantage of deep and narrow joists, to which there is no limit but in the lateral bending, for which transverse struts afford a remedy. These are usually placed in pairs crossing like an ⋈, and are then called *herring-bone strutting*. A row of it should be repeated at intervals not exceeding twenty times the width of a joist.

Trimmers are the short joists running at right angles to the others, to form the edges of well-holes for stairs, hearths, &c.

Trimming joists are those which bound such openings, but run in the same direction as ordinary joists. They should, however, be stronger than these, because they have to receive by mortices the ends of the trimmers, which themselves receive in the same way the ends of ordinary joists.

Girders are beams now usually laid across wide rooms, at considerable intervals, these intervals being then spanned by joists shorter than would be required to span the width of the room. If used at all, as they obviously concentrate the whole weight of the flooring on the points where their ends rest, these points should be strong piers, and the intermediate wall (as it is relieved of all extraneous pressure) may be a mere screen, as in the Gothic vaulted buildings. But though this concentrative principle be highly proper and economical in *that* style of construction (where no dependence is placed on the transverse strength of materials, and all the pressures seem collected and reduced into the

smallest possible number of conductors or resisting masses, as water is collected into drains), the case is widely different in our comparatively rude and artless modes of building, with lintel, beam, and breast-summer, *à la* Stonehenge, Crystal Palace, or Oyster-grotto. In such primitive methods, the fallacy of the concentrative or *girder* principle has been well exposed by Bartholomew. If, says he, a beam support a series of joists, it must be strong enough to bear not only the whole required burden (the actual flooring), but also the weight of the joists besides, while they support no part of the beam's weight. Thus there is a wasteful *delegation of burdens*, or a change of supporters into support-requirers, of working parts into idle parts, which (accumulated sometimes three or four deep) will be found to pervade our modern construction, and load its few effective parts with much surplus material (independently of what is needed to smother up the construction, and to mimic appearances of ancient architecture). "The quantity of material consumed in the girders of a floor will bear all the burden to be supported, except that weight which will be supported [directly] by the walls themselves; hence, if the quantity of material in the girders be divided so as to support conveniently the flooring boards, *all the material which would otherwise be used in the joists will be saved*, and an excess of strength will arise; so that even the quantity of material in the girders may be diminished; for not only will the burden of the joists be taken away,

but the material will be saved from all the wounding caused to it by tenoning or otherwise fixing the joists into or upon the girders, which frequently destroys from one-fourth to one-half of the strength of the materials." This last-named waste is necessitated solely by our unaccountable taste for reducing a ceiling to an inverted white-washed floor. Once admit that the construction (the architecture,—*tecture*) of a ceiling or any other work need not require hiding—that it *may* be such as to bear exposure, and there ceases at once all difficulty about how to ornament it (about choosing a *style*)—and all motive for these extravagant and senseless expedients to bring all the members into one plane.

In floors beyond a moderate width, it is evident that (unless the flooring boards increase in thickness proportionally to the scale of the whole) there must be more than *one* set of bearers interposed between the first supports (walls) and the final load (flooring-boards). The principle soon developed in such cases is, that whatever the number of intermediate orders, the primary bearers should contain as *much*, and the succeeding orders as *little* as possible, of the whole material; and this we find constantly aimed at in old works. Again, where the supports are rather walls than piers, (as in all our domestic buildings,) the first order of bearers cannot distribute the weight too equally; or, in other words, cannot be too numerous. Hence the tendency of correct construction would be not so much to "discard" girders, as to multiply their number. Now, as our

piers nearly always exceed our windows in width, a little attention will always enable the designer to bring two girders upon each pier, and so reduce their intervals to *half* the usual one (viz., the width of a pier and window). Further, a pointed arch of any kind will enable one to be placed without impropriety over the centre of each window, reducing their intervals to *one-third* of what is usual; or, if one be also placed over the centre of each pier, to *one-fourth* thereof. The roof of the nave at St. Albans Abbey is an instructive example of this.

As we have elsewhere observed, however, that the wide and sparse fenestration of English dwellings is solely due to the window-tax, and that there can now be no rational motive for lights wider than about two feet, separated by piers generally narrower than themselves (somewhat as in the early Venetian style), the common arrangement of girders, one over each pier alone, would (supposing the system thus rationalized) reduce the bearings of joists to 3 or 4 feet, without any of the above contrivances.

As for the use of girders to support a cross-wall or partition in an upper story, over an undivided room below, they are evidently only internal breast-summers; and, like those expedients, wholly indefensible and inexcusable under any circumstances whatever, or in any materials. Indeed, the subjecting lengthy bars or beams, or any masses longer than twice or thrice their depth, to a cross-strain or any force tending to bend them, is (except in the

unavoidable cases of flooring-boards and their immediate bearers) at once too unnatural to occur to barbarous builders, and too inartificial to be palmed off on any civilized community not blinded by excessive sophistication; and we owe the appearance of such things (unseen till the last few years) solely to a school of self-styled "engineers," that seem to expect the world to believe rude and artless shifts become prodigies of science by a mere change of their material; that *skill* is shewn in getting made in iron, things too rude and skilless to stand in weaker, or be tolerated in more familiar materials; and that because its strength and stiffness enable it to retain almost any form, the produce of Colebrook Dale furnaces is not only a substitute for brains, and to do *their* work, but *they* do get the credit of it. If such a thing were to be found, in any rude antiquity, as a beam of *stone* ten or twenty times as long as its depth, supported only at the ends, and loaded somewhere between them with a pillar or a wall, we should be humiliated at the low state, not of art or science, but of human intelligence or else honesty betrayed. But engineers would persuade us—and it seems to be swallowed by some—that though a thing be, in one material, too absurd for human perpetration, it becomes in another (wood) allowable or unavoidable, and in a third (iron) scientific and refined!

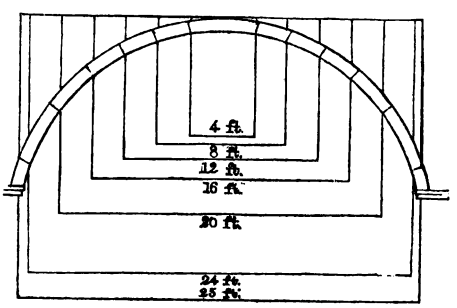
Girders to support a cross-wall may in *all* cases be replaced by the tied arch described above as a substitute for breast-summers; or still better by that

proposed in our last note. This, indeed, must necessarily appear below the ceiling; but I see no particular beauty in modern ceilings to be interfered with, nor any reason why all their bearers should not shew themselves now, as well as in the times whose works we are obliged in other matters to counterfeit.*

Quartered Partitions to divide the upper apartments of buildings, where more numerous (as they generally must be) than those below, are highly objectionable on account of fire, and have been perpetrated solely from the decline of brickwork making it impossible to obtain thin walls to be trusted; though with bricks and workmanship equal to the

* In this case the spandrils over the arch may be built up to the level of the ceiling, in common brickwork, plastered, or, what is far better, in a brick so formed as to make a light perforated wall, with the openings of an ornamental shape; and the faces of this, as well as of the arch itself, may have, for superior work, a coat of finer clay with any ornamental colouring or porcelainous glaze. The radius, 12 feet 6 inches, is chosen for these arches, that they may not, when thus applied, descend at their springing nearer to the floor than about 7 feet, in any case. To shew this, the subjoined figure represents such an arch, cut off at various spans from 4 feet to the

Fig. 10.



average of those used a century ago, there could be no objection to a $4\frac{1}{2}$ inch wall supported as above described, and which ought to be cheaper than these partitions. Until they can be superseded, however, it should be insisted that they be *self-supporting;* though, as this requires a distinct design for each, they are now commonly left to the workman to design, and consist merely of upright pieces of quartering entirely dependent for support on the girder below, which *ought to be suspended from them.* The great depth of such partitions of course enables us, by studied trussing and use of diagonal pieces, to throw their weight wholly on the end supports; nay, even to make them serviceable as bearers of far more than their own weight; so that, instead of requiring under them a stronger beam or joist than the floor timbers in general, they should require none, and help to suspend the flooring on each side.

---

full diameter of curvature, 25 feet; and by dropping from its springings the constant height, $6\frac{1}{2}$ feet, we see by the smallest rectangle thus formed, that a passage 4 feet wide need not be higher than 6 feet 9 inches to admit the use of this arch. In the same way, a width of 8 feet, as seen by the next rectangle, requires no greater height than 7 feet 3 inches; and

A room 12 feet wide, need not be higher than 8 feet 4 inches.

„	16 feet wide,	no higher than	9 „	8	„
„	20 feet wide,	„	11 „	8	„
„	24 feet wide,	„	15 „	4	„
„	25 feet wide,	„	17 „	0	„

These are about the *minimum* heights given to rooms and passages at present; so that by adopting this radius for the arch-bricks, they would apply to all possible spans, up to 25 feet, without inconvenience. Any doorway occurring in walls thus supported, would properly require an inverted segmental arch under it.

The only use for a timber across the foot of such partitions, should be as a tie to confine the feet of their diagonal trussing-pieces, which, where there is no door in the partition, may form a triangle as large as it will contain; and where there is a door (even close to one end, but better the nearer it be to the middle), triangles as large as possible should be formed, and the principles we are about to mention with regard to roofs applied.

As the object of flooring is to support a horizontal plane of any matter, and make it equally strong throughout, so the end of all roof-framing (we might even say, of all architecture,) is to uphold two or more inclined planes of tiling or other covering (it is archi-*tectura*); and the only true way of proceeding to solve such a problem is the analytical way, or beginning with the consideration of the thing sought, to reason backward, till we get to the primary supports, and determine *last* those things that must be executed *first*. Hence any attempt to systematize this whole art must have to begin at the *roof-covering*, and not, as an eminent critic has lately attempted, at "the foundations," though he has shewn that beginning at the wrong end of a thing need be no hindrance to discovering many valuable truths.

Now it is easy to see that the covering, whatever it be, should have as few *horizontal* seams or laps as may be; because these, in proportion to their frequency, lessen the inclination of the covering-plates as compared with the general slope of the roof, and

so necessitate a higher framing; while seams running down the slope have no such effect. Hence these latter are always made most numerous, or, in other words, the pieces of covering, whether lead, slates, tiles, shingles, or even the panes of the "Crystal Palace," always have their length slopewise, or smallest dimension horizontal. Now the immediate bearers must (as in a floor) have their length at right angles to that of the covering-pieces; for, whichever way they run, they must be at least equal in number to the seams running in the same direction; so that when (as is commonly the case) the covering-pieces are stiff enough to require each only two supports, these supports will be economized in number by taking the ends rather than the sides of those pieces; and even when the covering is flexible, as lead, requiring to lie on a continuous surface, it is better that the seams of the two layers of covering should cross than run parallel; and thus in *all* cases the immediate bearers of the covering, whether laths, slate-battens, or boards in contact, must run horizontally. In a gabled building, then, (the gables being always on its shortest sides, to avoid unnecessary height,) as we can put no limit to the distance between the gables, these horizontal bearers could not, without being wastefully strong, span from one to the other, but must have intermediate bearing-slopes; which in some cases have been furnished by internal gables built on the cross-walls, or on arches thrown across for the purpose; but more economically by wooden open-framed gables,

called *trusses* or *principals*, whose perfection is to discharge all their own weight, and what they receive, to the side walls; and this vertically, not (as the arch does) with an oblique thrust outwards.

We see, then, that only *two* orders of bearers can ever be necessary between the walls, that bear all, and the tiles, that are borne by all. But long unreasoning routine, handed down from the days of leaded cathedral roofs, gradually perverted and modified in the wrong direction by interested tradesmen, has brought us to the present almost universal employment of *four* such intermediate orders. This is a glaring instance of that abuse which Bartholomew terms *delegation*, as he has well pointed out (Pract. Arch. § 4735), and is of the same nature as the fallacy of widely-separated girders for floors. The first order of bearers, *i. e.* the trusses, are seldom in a modern roof less than 10 feet apart, though they rest not on *piers* in which the strength of the walling is concentrated, as in Gothic buildings, but on *walls* equally strong throughout. Hence we have (1st) a superfluity in the walls. Again, this great interval renders heavy secondary bearers necessary to span from one truss to another; and though the whole edge or two slopes of the truss (called the *principal rafters*) must be of equal scantling, and almost equally fit to bear these at every point, we place them only on five points, viz., one on the top (called a *ridge-plate*), one on each foot (called *pole-plates*), and one on the middle of each slope (called *purlins*.) Hence (2ndly) a superfluity in the

principals, being as strong where unloaded as where loaded; and (3rdly) a waste in these secondary bearers, from their needless length of span. Again, the great interval of these, obliges a third order of bearers, running down the slope, and called *common rafters;* though we have seen that only two orders ought to be necessary. These are superfluity the 4th; and still we want another order—the laths, or battens, or boards—to perform what the second order should have done. Hence a 5th waste.

A more definite estimate of the loss by *two of these items alone* may be had thus. Each order of bearers must have strength enough to bear the whole of the final covering, and also all the succeeding orders after itself. Let us call them A, B, C, D, and the covering X. Now as A suffices to bear B + C + D + X, something *less* than A, would suffice to bear D + X. That is, a less quantity of timber than that in the present trusses A, would, if divided into a sufficient number of trusses to allow their intervals to be spanned by the laths D, suffice to bear D and X, or to answer the whole end of the present materials in A + B + C. Thus the whole of B and C are superfluous, and so is the portion of A employed in supporting them; viz., a quantity which is to A, as B + C is to B + C + D + X. Thus, independently of the waste in walling material, and of that arising from needless length of bearings, we have, for loss, by the delegation error alone,

$$B + C + \frac{B + C}{B + C + D + X} A.$$

That is, B representing the whole matter of the pole-plates, ridge, and purlins, and C the whole of the common rafters, we see that the material of all these, and whatever goes to support it, in trusses or walls, is superfluous. But we must not suppose the waste in *expense* is commensurate with that of *material*. It is far less, for this reason. Though the light and numerous trusses would, to support a given load, require less matter than the few and heavy ones, yet they would contain more workmanship; and this is evidently an universal rule, that delegation, while wasting material, saves labour, at least the labour of cutting and fitting;—for it lessens the number of pieces and joints. There is therefore a certain degree of subdivision and lightness, at which the increased elaboration would exactly set off the saving of material; and thus make a roof, or any other structure, just as strong, for the same expense, as our present ones, though with less matter; hands and brains having supplied its place. And though equal in cost, such works would be nobler and in truer taste, because a given sum is better spent in handiwork applied to save material, than in material applied to save handiwork;—the former being *art*,* and the latter the exact reverse of art.

* A very low kind of art, doubtless, but still an essential part of architecture; being in fact that which constitutes the whole progress remarked by ordinary observers in the mediœval styles. The whole passage from the ponderous Norman to the fretted Tudor chapel, *as most men see it*, merely proceeds by constantly *substituting work for material.*

This must not be confounded with another art-progress, which,

But taking economy as the only question, there is no need for the expense of either mode, since there must be a certain degree of lightness and elaboration, less than we have supposed, but still greater than in our present works, which will give the minimum of total cost; and this degree must vary with all variations in the relative values of materials and labour. Thus the cheapest form for any work would be one of more mass and less elaboration now than in the middle ages, because materials (or what is the same in effect, physical force, mechanical or human,) are now more abundant, and skilled hands scarcer; so that the difference of value between skilled and unskilled work, then remarkably small, is now exaggeratedly great.

Still there is much room for saving, by greater subdivision of material than now practised; and we are not to listen on this point to tradesmen, who

though simultaneous with it for some time, culminated, and fell long before it. This nobler kind of art (which, instead of growing till the latest period of mediœvalism, rose with the early and declined with the late Gothic,) was not the making hand-work replace material, but brain-work replace both. This, as well as the other art, has its converse. There is another kind of delegation besides that so called by Bartholomew. Besides the delegation to mere matter-carriers, of what skilled hands should do, there is the delegation to *hands*, of what *heads* should do. And this, whose beginnings are evident in the late Gothics (especially that of England), and increasingly ever since—this is the distinctive principle of *engineering*, as opposed to *architecture*. In pure architecture (as that of the 13th century) no portion of manual labour is applied to save thought. In pure engineering, the exact reverse of this is seen,—the day's work of *a thousand* often squandered to save an hour's work to the *one* designer. In this their whole difference, I believe, will be found to lie.

are always for the opposite course, spending material to save work. Bartholomew has well observed, that in most modern buildings, by bringing two trusses, instead of one, on the wall between each pair of windows, their intervals may be reduced to 4 or 5 feet (and it might be still more by rationalizing the width of windows and piers); and that, for a 5-ft. interval, horizontal bearers 3 inches by $1\frac{3}{4}$, placed $8\frac{1}{2}$ inches apart, will serve at once to receive "Duchess" slating; or similar ones $2\frac{1}{2}$ inches by $1\frac{1}{2}$, placed 7 inches apart, "Countess" slating; these scantlings being of course increased or diminished with the interval of the trusses. In all such cases the most economical arrangement must depend on observing a certain relation between the span and the interval of two bearers (*i. e.* the length and breadth of the rectangle they enclose); and whatever relation this be, there appears no reason why it should not apply to the bearers of *each order* alike, and indeed to floors as well as roofs; so that whatever ratio is best between the lengths and intervals of girders, would also be best between the spans and intervals of the joists resting on them, or between the spans and intervals of trusses, or of the purlins resting on *them*, or the subordinate rafters (if any) resting on *them*, and even the slate battens or laths subordinate to *them*. Thus all the rectangles into which the plan of a floor or roof is divided and subdivided for support, should, from the greatest down to the least, be somewhat similar in form; and where they differ greatly (some ap-

proaching a square, and some a lengthy oblong), the work is inconsistent and illogical.

As far as regards trusses, this seems to have been recognised by the Gothic builders, who latterly hardly ever placed trusses at intervals much more or less than *a fourth* of their span; though in early examples (as Canterbury Cathedral), before the introduction of subordinate rafters, the span, if large, is sometimes 6 or 8 times the interval. In either case, the secondary bearers or purlins should, to be consistent, be more numerous than we make them; viz., in the first case 7, and in the last case 31, between each pole-plate and the ridge. And any further subdivision would, if it gives (as in the first of these cases) 15 of these purlins in the breadth of the building, give also 15 subordinate rafters in the space between two principal ones; and 15 final bearers of the covering between every two purlins. Thus, even on this assumption, that bearers cannot be economically placed nearer than *a fourth* of their span, we see that it must require a very large roof indeed—one having no less than $16 \times 16 = 256$ courses of tiles or slates—to render the fourfold subordination of bearers preferable to the twofold (for we have seen that there cannot be *three* orders, because the last must be lengthwise, and the first transverse to the building; so that if more than *two*, there must be *four*). With a lead covering, however, as the last bearers take the form of close boarding, the last but one will have their intervals regulated only by the stiffness of these

boards, and so be nearly as close as joists or subordinate rafters usually are. Hence there will be a certain span of roof, at which it begins to be more economical to make them subordinate rafters, than to tie the feet of every pair, and make them into a distinct truss. And the scale at which this "delegation" begins to be proper, will vary with the thickness of the boarding for lead, and be in fact defined by a certain ratio between the span and the thickness of the boards. And the span (measured in boards' thicknesses) at which this begins to be the case, will be smaller now than in the middle ages, because we have more materials and less skilled labour; and must, in an identical problem, use more of the former and less of the latter, to give the cheapest solution. But whatever ratio of span to interval of trusses may (for the time and place) be the cheapest abstractedly, this ratio may, on approaching that limiting span, be considerably stretched, or the trusses placed closer, rather than resort to an increase of the orders of bearers from two to four. Still, there will be a certain moderate span (or rather number of boards' thicknesses to the span), beyond which our present fourfold subordination becomes (in *leaded* roofs) cheaper than the twofold. And where this is so, we shall have (on the above principle) this rule to determine the number of trusses, purlins, and common rafters. Knowing the span, and approximately the best interval for the common rafters, find, between these, two mean proportionals. The larger will be about

the best interval for the trusses,—the smaller, that for purlins (always more numerous than commonly made). Then, by so eking out and eking in the three smaller of these measures as to make them divide each other exactly, you get the very best intervals and numbers of each member.*

Thus in leaded roofs of a large size, each oblong of the plan, comprised between two trusses, will be divided crosswise into nearly *similar* oblongs, each bounded by two purlins, and these again into nearly *similar* ones by the common rafters. But in using tiles, slates, or any covering-plates stiff enough to need support only at their ends, we must either stop short of this last subdivision, or go one step further, and divide the oblong between two common rafters again into *similar* oblongs by the laths or battens. Now, though there must be a scale at

* Or practically thus:—Divide the span by the interval of two common rafters (taken from centre to centre); square this quotient, and find the cube-root of that square, to one decimal. If this root be very near a whole number, take that number both for the number of common rafter intervals in one interval of trusses, and for the numoer of horizontal bearers, or intervals thereof (according as it is odd or even), in the whole span. Otherwise, take the two whole numbers between which the cube-root lies, and use the *larger* for this latter division, and the *smaller* for the number of rafter intervals in one truss interval. Thus, let the span be 34 feet, and suppose a common rafter at every 14 inches of length. The former divided by the latter gives 29.1 &c., which squared is 846.8 &c., whose cube-root is 9.4 &c. Here the numbers to be used are 9 and 10,—the smaller, 9, for the number of rafter intervals to one truss interval, so that there will be a truss in every 10 ft. 6 in. The other number, 10, being even, I take it for the number, not of horizontal bearers, but of their intervals; so that I make 11 of them, viz.—the ridge, the pole-plates, and *four* purlins upon each slope.

which this would become economical, that scale has probably never been approached in practice. At least, in all roofs not of extraordinary span, and not leaded, we may consider the twofold subordination, revived by Bartholomew, decidedly the proper one; and to determine the interval of the trusses, we have simply to find *one* mean proportional between the span and the interval of horizontal bearers (which is decided by the length of the covering-plates, less their amount of lap).*

The omission of subordinate rafters would also remove the chance of several ignorant abuses now common. Thus we sometimes see a common rafter made to serve also as principal rafter, without even any increased strength, and the purlin that should rest on the latter, and uphold a range of the former, simply *nailed up* to both, as if to act as a talisman. Still commoner is it to omit the pole-plate, or defeat its object by letting the common rafters' feet touch the wall-plate or wall, against which they *must* then exert a thrust, to be restrained by no means short of a distinct tie and trussing to each pair; whereas the pole-plate should collect their pressures into the principal rafter, so as to be restrained, several at once, by one tie, or trussed set of ties.

* One mean proportional is found by multiplying the two extremes together, and taking the square-root of their product. Or if one line stand on another at right angles, and from their meeting-point the two given lengths (span of roof and gauge of covering) be set off opposite ways on the latter line, and the points thus found be made the extremities of a semicircle, this will cut off from the standing line, the required mean proportional, or interval for the trusses.

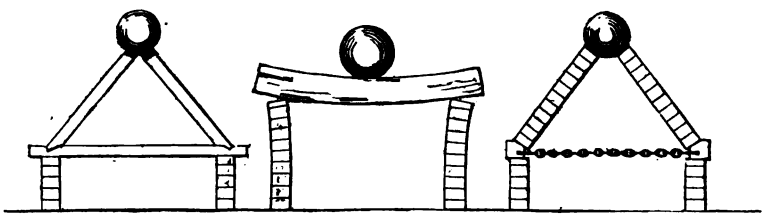
We come last to the *trusses*, the primary bearers of the roof, as girders are of a floor; but while economy of space almost forbids the latter to be more than, like the minor bearers, mere beams, or if arches, very shallow, and therefore *in themselves* wasteful of material; the unlimited space for the roof allows its bearers to expand upward into whatever form and structure may be proved to do most work with least means; and we may regard it as a providential appointment that the very forms proper on this account, also give the covering the form fittest for *its* end of keeping out wet. It might have been otherwise; the best form for the bearers, abstractedly, regarded as mere means of bridging the space, might have been far from the best for the covering, regarded simply as a shelter, and *vice versâ;* but it has been so ordered, that what is best on one account, is best on the other too. And hence it requires a marvellous state of things, it argues a truly wonderful civilization, to succeed in unsettling or mystifying this point. Progress must have attained a steam-pace indeed where such novelties as these can be developed. New styles of architec-

Fig. 11.

ture are nothing to them: we may expect next a new multiplication table.

The simple *truss*, of three pieces (fig. 12.) is the

Fig. 12. *Fig.* 13. *Fig* 14.



germ of all correct carpentry or *framed* architecture, (no matter in what material); just as the arch is the germ of all scientific masonry or *built* architecture, in any material.

It is plain that a weight on the top of the truss has no tendency to *bend* any one of the three pieces; it only compresses like columns the two rafters; and, by tending to separate their feet, it stretches the horizontal piece or tie-beam. Any weight can be borne, therefore, short of what would either directly crush the former, or pull asunder the latter. Hence the perfection of the arrangement, all its materials having their *direct* or utmost strength made use of; while in the barbaric modern beam (fig. 13), which, to support the same weight, requires far more matter than the whole three timbers of the truss, the material is attacked at the utmost disadvantage, the smallest possible portion of its strength called forth, the strain *wholly* a bending one, and change of form inevitable (in fact, a matter of exact calculation, varying with the load,) whence also the sinking curvature gives it a power to thrust

apart the supports, like an arch. Now, whatever swerves from its *designed* form, by the weight of its *designed* load, is a FAILURE; and to calculate or allow for this change (as the engineers pretend to do) is not science, but the mere surrender of art. Returning to the truss, you see it would answer equally well with a chain for a tie, and a pile of loose pieces, unconnected except by the pressure, for each rafter, (fig. 14.) For the timbers (fig. 12) do not act at all by their *stiffness;* it is not depended on, any more than the adhesion of mortar is depended on in correct masonry. And these are tests in each art. Building, or masonry, is false, unless it will stand independently of all *adhesion, i. e.,* stand with *dry sand* in place of mortar; and framing, or truss-work, is false, unless it will stand independently of all *stiffness* of the separate pieces, *i. e.,* will be as a whole perfectly stiff, though composed only of *chains* and *built columns* in place of timbers. The parts that might be replaced by chains are called *tensile* parts, which we shall represent in future by dotted lines; and the parts that might be replaced by built columns are called *compressile* parts, which we shall represent by full lines.

First, as to the height of *pitch* or inclination of the rafters, there will be, for every material or combination of materials in which a truss can be made, a certain angle of pitch that is most effective with least material, considering the truss alone. In a higher truss the length of the rafters would

increase more than their scantling diminishes; and in a lower one, their scantling (and that of the tie) would have to be increased more than we save in their length. But as different materials have all manner of ratios between their compressile and tensile strength, and therefore between the scantlings of rafter and tie, necessary to make one just as difficult to crush as the other to tear asunder, every material has a different angle of greatest economy; those whose compressile strength predominates (as cast iron) calling for the highest truss, and those whose chief strength is in tension (as wrought iron) the lowest. And where two materials are used, the question of least matter being no longer identical with that of least expense, the problem will be complicated by the variable relation of their prices. But whatever be the cheapest pitch for the trusses regarded *alone*, that actually cheapest for them *and the covering*, will always be *lower* than this. It will occur where any further lowering would add to the cost of the truss, more than it saves in the quantity of covering; while a greater height, though saving material in the truss, would save less than it spends in increased covering. Hence the more costly the covering material, relatively to the material of the framing, the more will the pitch be lowered.*

A rule has been set forth, that is said (omitting

* The most economical height will be a function of *six* variables at least, and its determination is a problem of the same nature as that by which a French mathematician is said to have calculated the inclination the planes of a honeycomb should have (and actually

the flat coverings of rainless Egypt and Syria, which are not properly *roofs* at all,) to give the pitch of roof used at each place, in a function of its latitude

---

have) to effect the greatest economy of wax. He *might* have proceeded to this somewhat more complex, but eminently practical, application of his differentials to a daily use in human architecture; and so *might* our engineers (though I cannot find that it has ever occurred to one to do so); and with a fraction of the mathematics they have spent in mystifying the unlearned, to palm off their crude failures for wonders, they might probably have evolved a rule by which every carpenter might, bee-like, apply the results of analysis to economize matter in every roof he makes.

Let s be the span of a truss, h its height, i the interval of two trusses (all in feet, and the latter found by the rules given above, pp. 98, 99); and let a = the cost per lineal foot of such a bar of the tie material as would be just pulled asunder by an unit of weight; let b = the cost per lineal foot of such a bar of the rafter material as would be just crushed by that same unit of weight; let c = the *cost* of a superficial unit (a slater's square) of the covering-planes, including all their bearers after the principal rafter (their number being determined by the above rules, and their scantling by the well-known formulæ for beams); and w = the *weight* of the same superficial unit of covering. Let this weight be supposed concentrated on the *apex* of the trusses (which we shall presently see is, or ought to be, really the case), and let the scantlings of the tie and rafters be such as would just bear *thrice* the actual strains thus resulting. Then the cost of one truss, and all that it bears, will be,

$$\text{Cost of covering} + \text{cost of rafters} + \text{cost of tie} =$$

$$\frac{c\,i\,\sqrt{4h^2+s^2}}{100} + \frac{3\,b\,i\,w\,(4h^2+s^2)^{\frac{3}{2}}}{400\,h} + \frac{3\,a\,s^2\,i\,w\,\sqrt{4h^2+s^2}}{400\,h}$$

Now it is easy by differential calculus to find what height h (in terms of $a\ b\ c\ i\ s$ and w), or at least what relation of h to those numbers, will make the above sum *a minimum*. I do not give the result, because, having it only in an equation of the 5th order, and not being mathematician enough to bring it into a more manageable shape, this equation would be of no use to the mechanic, and any mathematical reader may obtain it for himself in a simpler form, and *possibly* in one reducible to a popular rule; which is much to be desired.

only. Let us see how this applies. The roofs in the torrid zone, which by the latitude theory should be the lowest, are always pitched at 45° or higher. Nowhere else are they so invariably high, though the violence of the rains, sufficing to carry them off almost *any* slope, would be a real reason for lowness. A cascade will dash off a surface and hardly wet it, which a sluggish shower would rest upon long enough to penetrate. But the simple explanation is, that the tropical resources for the outer covering cost almost nothing compared with the framing. On the other hand, the roofs of the Greek temples (not their other buildings) were the lowest ever used (except in mock architecture), because their trusses were most inexpensive compared with the elaborate tiling of sunk marble slabs. So the lowest modern roofs are the Italian, because they have the most elaborate tiles; and the terms *a lead pitch*, *a slate pitch*, &c. among ourselves, shew how much we attend to the latitude. *Our* great object, however, being concealment or disguise, we aim not at the most economic, but simply at the *lowest* pitch for each material, that will not let the wet penetrate,—a limit very undefined. But the whole foundation for the latitude story is no more than this: that dividing the world into two parts, the regions of snow, and the regions of no snow, roofs in the former have sometimes (not often) been made as high pitched as 54° or 60°, with a view to throw it off.

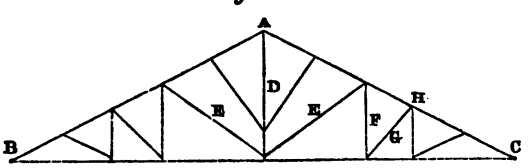
We have supposed, in Fig. 12, the load concentrated on the top of the truss, whereas it is equably

spread along the rafters. Now this would require, if we made these rafters for ourselves, of dead matter, as in Fig. 14, that we should give them an outward curvature like the haunches of a Gothic arch; but the nature of the material, the rafters being already made for us, and made straight-grained, precludes this mode of equilibration; so that we must seek a substitute for it, in subdividing the length of the rafter, regarded as a beam, by intermediate supports;—if possible, one at every place where it receives a secondary bearer or purlin; but if these be very numerous, we must be content with a support to the rafter's centre, where it would bend most; then another to the middle of each of its halves, where *they* would bend most; and so on, halving and quartering, as far as we think the saving of material in the rafter itself not counterbalanced by the matter and work thus added.

Now let us see how to get these supports, or rather *weight-transferrers*, which are to take the load from different parts of the rafter, and transfer it all to the apex, because the straight-lined truss (or "triangular arch," as some call it,) is only fit for a concentrated central load. Let us hang from the apex A (fig. 15), a tensile piece D, reaching down to the tie. Its foot, no less than A, will be a fixed point, *i. e.* immoveable by anything short of the destruction of the truss. Hence we can carry from this, as a firm base, two compressile columns E E, called *struts*, either to the middles of the rafters, or to any point at which

a chief purlin is placed on them. Again, a footing made higher up in the suspender D, will afford a base for any other pair of struts to any higher part of the rafters. But, for subdividing their lower half, we shall have to drop a suspender F, from the point where some higher strut meets them, and its foot will give us a fixed point, from which to carry a secondary strut G, to the point requiring support, as H. Thus the load of roofing collected on H, by a purlin or other horizontal bearer, is transferred partly down the rafter to the wall C, partly down the strut G, to the foot of F. This suspender F refers all pressure on its foot to the top of the primary strut E, from which and from the rafter it jointly hangs; and E refers its share thereof to the base of the suspender D, which thus finally collects all pressures from struts, and concentres them at A, where we saw the straight form of the rafters required the load to be collected. And thus all pressures come, first or last, to be transmitted down them *lengthwise*, with no tendency to bend them or any other part.

Fig. 15.



Observe that secondary suspenders, as F, can only receive a strut at their foot, and not at points higher up, as D does; because, being unbalanced by a corresponding strut on the other side, these would push

against the suspender with a bending force, which must never occur unresisted, against any piece of a true truss. Every timber must admit of being replaced either by a chain, or a built pillar of thin pieces kept together only by pressure. It is well, in designing, to fancy them thus, because in truth they will not, any more than a chain or vertebral column, bear a side push or pull, however slight, without *some* bending; and *all* bending or deflexion allowed is a surrender of art. All dependence on the stiffness of any material but wood, or on *that* except in the smallest bearers of three or four feet span, was ignored in times of true architecture, and more completely so the greater the scale; and it must still be ignored wherever true economy is aimed at,—it must be left to the engineers, the substitutors of matter for mind.

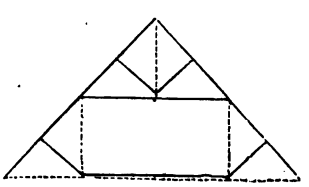
The natural object of all the inner timbers, within the triangle of the truss, is to afford intermediate supports along the otherwise bending rafters. It is only as a means to this end, that the *tie-beam* also is suspended at several points. But this object, which is really only subservient to the other, has now strangely come to be regarded as the chief or ultimate one, for two reasons. The vice of over "delegation," above explained, has tended to collect the weight of the covering into a few (commonly only *five*) points on the truss, by the pole-plates, purlins, and ridge-piece; and on the other hand, the ridiculous tinsel of plaster ceilings, suspended to the tie-beams, has, by its liability to crack at the

slightest flexure, called for more attention to the straightness of this member than of the rafters; so that we often see it with more suspensions than they have struts.

The middle suspender of a truss is called a *king-post*, and any other vertical suspenders, as F, *queen-posts;*—names calculated to mislead, as the term *post* implies in all other cases a supporter standing on what is beneath, instead of a suspender hanging from what is above.

When two queen-posts have no king-post between them (fig. 16), as no base exists for struts to be carried to the points whence they hang, these points must be kept apart by a horizontal compressile member called a *collar-beam;* and this, from its tendency to bend (far more than a tie-beam, that acts by tension,) will require suspension in the middle, by a short king-post, from which struts may go to the upper parts of the rafters. This construction, found in some of our cathedrals, is fit only for roofs of high pitch. When the feet of the queen-posts end in straps of iron embracing the tie-beam, they would be liable, by the struts they receive, to be pushed inward, and slide towards each other, unless kept apart by a thin timber laid on the tie-beam, called a *straining-sill.*

Fig. 16.



Anciently, when the connection of suspenders with what they hang from, or what they suspend, was made by wooden pins driven through both, they were necessarily in different planes; and either the suspenders were divided and placed on the two sides, with the thickness of the truss between them; or else the whole truss *except* them, divided into two, and the suspenders in a single thickness enclosed in the middle. The former is best.

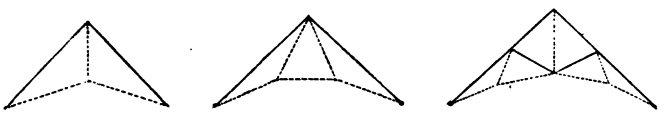
Now that we use iron straps for all the lower connexions, we keep all the members single and in one plane; and it is important to make struts never spring from the suspended parts, but directly from the *suspenders themselves*, by cutting away the latter so as to leave sloping shoulders, or *abutments*, on which the struts lodge. Thus the whole suspender is cut out of a wide piece of wood, and its full width left only at the foot and head; the latter having also inclined abutments to fit between the rafters that sustain it, like the key-stone of an arch between the other stones.

These abutments should not fit close when first made; they should in both cases be less inclined to the horizon than the ends of the timbers that meet them; so that the shrinking of the suspender in width, by rendering the abutments steeper, may bring them to a perfect fit. Similar changes throughout a truss always cause it to sink somewhat in becoming seasoned; and therefore suspenders should never be long enough to touch what they suspend, that in sinking they may not punch it

down, but simply allow it to subside by its own weight, with the straps on which it lies; and then it can at any time be wedged or screwed up into its original position. The changes of form by seasoning (diminishing the *scantling* of timbers), are often now much greater than those arising from their compression and extension in *length* by the strains they bear. These latter, however, should be carefully considered, and allowed for by making all compressile pieces a little longer, and all tensile ones a little shorter, than in the design; the aim being to produce the exact *designed* form *after*, and not *before*, compression and extension. Dr. Robison remarks on the great care and skill shewn in a carpenter even approximating this fine result; and indeed more than a rough approximation to it is not possible at present, as we have no data for estimating the compression or extension of different materials (or at least of timber) produced by given pressures and tensions. It is highly to be desired that we had, and then these delicate corrections might be made (as all carpentry design *should* be) a matter of rigid calculation. Meanwhile, it is important to remember, because not generally known, that these compressions and extensions are not simply proportional to the forces producing them (*i. e.* the pressure or tension per square inch on the sectional area of the piece), but jointly on its *length* also; so that the very *same* number of lbs. pressure will shorten a strut 10 feet long, *twice* as much as it shortens one of 5 feet long, or nearly so.

The tie need not be a tie-*beam*, or extend straight across in one piece; but may be broken into two or any number of straight lines, provided only that it connect the rafters' *feet* by a line wholly independent of the rafters themselves, and having all its angles or junctions well secured, all turned in one direction, downward, and kept up by suspenders. And perhaps the ties should always be thus raised

Fig. 17. *Fig.* 18. *Fig.* 19.



where a ceiling is to be attached, as nothing can be uglier or more unnatural than the *passive* heaviness of a wide or drooping horizontal ceiling; though *exposed* tie-beams, with spaces between and above them, are, in a high building (as the Italian Basilicas), rather grand than not.

But though the line of tie may thus be raised above the base-line of the roof, it should never be so when consisting only of a beam. The common practice of *cambering*, or dragging up the centre of such a beam, above its natural level, is highly improper; wasting great part of its strength, as well as that of the king-post. Indeed, it would be a less evil to force it down several inches, than to drag it up one inch. Again, any tie-work which only connects the rafters at points *above* their feet, as in the letter A, is a fallacy, as the test of substituting chains and columns of loose pieces will at once shew;

the rafters being pulled inward out of straightness, and their portions below the tie tending to thrust out the supporting walls. This error is common in Gothic roofs, and hardly affects the old ones, from their great massiveness; but the imitation of it, now rendered fashionable by mimic churches, &c., is a misfortune. The opposite error to this is placing the rafters' feet upon the tie-beam not directly *over* but some way *within* the walls, as in London houses, so that the whole truss hangs between them, instead of reposing upon them.

All such errors will be avoided by designing all trusses at first as above, in *single lines*, and with a single line for the centre of each wall, and insisting that no line meet an intermediate point of another, unresisted; but that the junctions of three lines (as the centre lines of the wall, rafter and tie,) be effected always in a single point. The strain on each line, whether compressile or tensile, can then be found by the resolution of forces; and hence, from tables of the strength of materials, the sectional area just sufficient for each member to resist crushing or pulling asunder; and the actual scantlings should be made to exceed these, all in the same ratio, never less than treble. It seems generally forgotten that the most compact or *square* section must be best for all these members, that bear only a direct push or pull lengthwise.

Of course, all roofs where the opposite feet have no connection but the roof-shell itself (as in the Crystal Palace transept and its parodies), and all

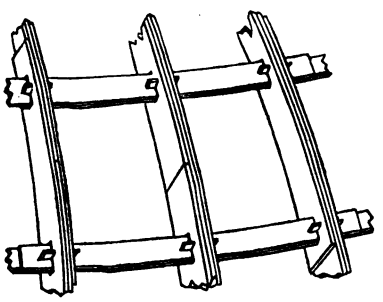
in which that connection is zigzag, or cut through for a fancy (as in Westminster Hall), are destitute of the truss principle; and instead of *reposing* on and *binding* together their supports, actually thrust them apart, unless propped from without. Using only the compressile, and not the tensile fibrous strength of their material, they are contrary to its nature, treating it as brick or stone; and having all the disadvantages of brick or stone vaulting, without its merits of durability and resistance to fire: the Gothic ones (peculiar to England) being moreover barbarous in taste, from their cumbrous *constructed* decoration, and from their ornamentists finding nothing better to copy than their own or predecessors' stonework. Indeed, the true architecture of *framing* (as opposed to *building*) seems an art never yet attempted, at least in the European world.

There is one case, however, in which curves on a large scale may be used with great advantage in carpentry. The cheapest of all buildings, to enclose a large given space, will be a circular one, because it admits this kind of roof—namely, a dome composed only of meridian-like ribs or rafters, intersected by horizontal rings; which, by binding them together at short intervals of height, prevent all change in their curvature, and enable us to give the dome almost any outline we please. The meridian-like ribs must spring from the wall at intervals of a yard or less, and be each composed of at least three layers of thin board, *not bent*, but applied flat together in a vertical plane, and their edges cut to the proper cur-

vature. The joints must be broken so as to occur in only one or two of the layers at once; and the layers require nothing to hold them together except the horizontal rings, which pass through a slit in the middle of their width, and have themselves a similar slit, into which a wooden key is driven on each side of the upright rib. These rings are also in at least two layers of thin board, *bent* all in the same degree, and also having their edges curved to a radius found by drawing a tangent to the dome's profile at that point, and continuing it upward till it meets the axis.

This capital invention of Delorme, one of the earliest modern writers on architecture, was first put in practice on a large scale by Moulineau, a carpenter, the self-taught architect of a roof to the Marché au Blé, Paris, late in the last century.

Fig. 20.



It is equally applicable to metal as to wood; and a knowledge of it would have saved enormous expense and cumbrousness in the round engine-houses of English railways, as well as in large conservatories. Thus the cubic contents of the Kew Palm-house, or "Crystal Palace," might have been en-

closed (as the Messrs. Turner's design shewed) with far less material, in combinations of domes, weather-proof, and with all the beauty of the former structure. But such domes, on a large scale, should have one feature omitted by Moulineau, namely, diagonal pieces across many of the oblongs formed between the meridians and parallels, to prevent any spiral twisting of the whole cage, by keeping all the angles of crossing invariable. Wherever timbers cross in only two directions, this is necessary to prevent their behaving like a parallel ruler. Thus diagonals called *wind-braces* are always proper in the plane of an ordinary roof-shell, between the principal rafters and under the secondary bearers; and in Gothic roofs, as Westminster Hall, these are constant features, and generally made of curved timber for ornament.

But the property of dispensing with all internal framing, though most complete in roofs on a circular plan, extends to those on all regular polygons, however few their sides, even down to a square. For, supposing them pyramids, whether with flat or convex faces, the wall-plate at the foot of each face should confine the feet of the two hip-rafters bounding that face, and form with them a complete truss; in which, as the tie is supported throughout its length, intermediate supports to the hips may be furnished by struts simply carried up from any part of this tie. These are commonly at right angles to it (the wall-plate), and meet the hips obliquely; and as they perform also the function of secondary rafters, they are regarded as a sort of

incomplete or interrupted rafters, and called "*jack-rafters.*" Thus, if all the wall-plates be so connected as to form a confining hoop, no framing is required to a pyramid roof, but what is contained in the planes of the roof-shell itself. But in pyramids of few sides, and a lower pitch than 45°, it is better to throw across from corner to corner, trusses in vertical planes, intersecting in the central suspender which is common to them, and remembering that they are not for the sake of tie (which is furnished by the enclosing wall-plates), but for the sake of more direct strutting to the hip rafters than is furnished by the other or "jack" rafters.

This kind of trussing (for support rather than tie) is still more necessary under the four valleys formed by the intersection of two roofs; as over a church transept, where the outward push of the valleys' feet, even if not confined by ties between the adjacent ones, would be resisted by the two walls running out from each; but yet some strutting to these long and loaded primary rafters is quite essential; and that in the great French cathedrals without central towers is very remarkable. Nowhere else, however, have either valley junctions or hipped terminations to roofs been attempted on a sufficient scale to call for much contrivance; which they certainly would, if the principle of saving material, rather than work, were to be carried out by light and numerous trusses; here becoming incomplete or "*jack*" trusses. Those jack-rafters indeed that extend from a valley-rafter up to the ridges, could only need trussing for support, and not

for tie; as their feet, meeting on the valley-piece, balance each other's push. But the jack-rafters that rise from a wall, and are terminated above by a hip, should have their feet restrained; and this (whether they be strutted or not) is most easily to be done by ties across diagonally, in the plane of the wall-plates, each connecting the feet of two rafters at equal distances from the corner. *One* such tie, called a *dragging-piece*, is often introduced, and should be always, both on this account and to increase the hoop-like connection of the wall-plates, and make the angle at their junction invariable by any inequality of thrust on them.

As for parallel roofs, enclosing between them long *gutters* (often miscalled valleys), though sometimes occurring to a small extent in Gothic churches, they are evidently unsuited to any latitude in which either snow or heavy rain falls. For snow (especially if the roofs be steep enough to throw it off) will soon fill these channels, and then the upper layers, melting first, will overflow them. And heavy rain collected from both slopes into so narrow and *almost level* a channel, will be liable to do the same before it has time to run away. And though this might be unimportant over a vaulted church, it is failure in the first requirement of building, and destruction to the modern plaster frippery, which lies at the mercy of the slightest leak. Hence even the necessary gutters upon (or outside of) the external walls should have their inner rim always the highest, to ensure any overflow being outward, and not into the building (for

which purpose the Gothic open parapets were used); and all good modern architects have wholly eschewed any other gutters than these; *i. e.* any over interior walls or arches; as the Gothic architects did also, with a few rare exceptions. As for those suspended over empty space, "Paxton gutters," and roofs springing from drooping unsupported beams instead of walls, they are too contrary to common sense to have occurred before the nineteenth century.

The objections to horizontal valleys, however, do not apply (with regard to rain at least) where a funnel-like arrangement of four slopes collects the water, not to a lineal gutter, but to a single bottom, whence the drain at once descends. In many of the rejected studies for the "Crystal Palace" this seems to have been foreseen, by making each pillar collect the water of the surrounding sky-lights at once without gutters; and by this means it would certainly have been proof against rain, though not perhaps against a sudden thaw of snow.

As we have seen that economy would always prescribe a certain slope, from which the more we deviate, either towards steepness or flatness, the more cost we must incur, it has happened that both these deviations have, at different places and times, become fashions, *i. e.* conventional signs of the owner's wealth by his ability to waste. Thus in France, under Louis XIV., any one who built without a wastefully *steep* roof, would have been suspected of inability to afford it; just as among ourselves

the same suspicion would attach to any one who did not wear an absurd hat or coat; or a few years ago to any building of pretension whose roof was not wastefully *flat*, or even shewed itself at all. (By such wretched expedients must "respectability" be content to distinguish itself, when debarred the use of real marks of superiority, by the decline and levelling of the arts.) Now at the time of this over-steep roof test of respectability, (which we must allow to have a shade more reason, or less unreason, than the *over-flat*, or *invisible* roof test,) it is plain that very wide buildings must either have carried up their roof to an enormous height, or have looked quite vulgar; had not Mansard invented a means of making them, without exceeding a reasonable height, to shew nevertheless a surface of unreasonable and quite respectable steepness, by the formation called after him in France, and in England a *curb*-roof. This has a collar-beam, and the surfaces up to the collar-beam are very steep, while those above it are much flatter. The reason of its introduction into England, or rather London, has been simply as a means of evading the Building Acts, by the fiction of making the top story nominally a roof, and thus using, throughout the building, walls as thin as the law permits to buildings of one story less. In our construction, therefore, it is merely a slated wooden story, with its standards set within the walls of that below, and of course distressing and bending the beams on which they stand, most destructively.

JOINERY. FLOORS. (Plate 2.)

Folding floors (fig. 1.) are laid four boards together, which are shot as nearly as possible to fit a given space, and forced downward folding into their places.

Straight joint floors (fig. 2.)—The boards are carefully laid the length of the room in regular straight joints, and their heading joints should be either splayed (fig. 6), ploughed and tongued (fig. 7), or executed (as fig. 8), taking care to break them at proper distances. Sometimes the edges are also ploughed and tongued.

Dowelled floors (fig. 3.)—The boards are laid straight, joined with wood or iron dowels, or pegs let into the edges to confine them down, instead of nails from the face of floors, having them only on the edges of the boards.

Figs. 4 and 5 shew the methods of replacing a board in the middle or end of a dowelled floor, should one be damaged, without disturbing the dowels in the boards on either side.

Wainscot floors should have iron dowels, but deal floors may have dowels made of beech, as the dowel should certainly be made of a material much stronger than the floor. If beech, they should be formed as at A, and cut square; and being driven into round holes in the battens makes them draw.

The details of our modern "ornamental" or exposed joinery are intelligible only as modes of

counterfeiting the stone-work of Classic or "Renaissance" architecture, sometimes unavoidably modified a little by the nature of the material, in a tradition of three centuries; or pared down by the national taste for suppressing all appearances of necessity or utility, or for displaying cost by the utmost opposition to the nature of the material or work (as in joinery on a circular plan).

The upright and horizontal pieces of any framing are called respectively *stiles* and *rails*, and the thin filling-pieces *panels*. The grooves to receive panels are one-third the thickness of the framing; but the panels themselves may vary from this up to two-thirds thereof, or twice the groove. In this case they are *flat* on one side, coming no more forward than the groove; but on the other they come out to the same plane with the face of the framing, and are called *flush* panels. To obtain the strength of these without their bald flat appearance, the continental artists invented the mode of sloping off a margin all round them, so that the framing, though not more prominent than their centre part, might project and cast shadow on this margin; and these are called *raised* panels. In the richest variety, one or more mouldings separate the margin from the centre, and these are *moulded raised* panels. Panels may also be as thick as the framing, and either *raised on both sides*, or *flush and raised*.

The chief modes of finishing or marking the separation of the framing and panels are these:—

Bead-butt, or *bead and butt*, when the panel's face is flush, and two small round mouldings, or *beads*,

are struck along its two lateral edges; which is supposed an ornament.

Bead-flush, or *bead and flush*, when similar beads are struck, not on the panel itself, but on the edges of the stiles and rails, so that they form a bead border all round it, mitring at the corners.

Square, when the panel's face is flat, and the framing simply projects before it with a square edge.

Chamfered, when this edge is merely pared off to a narrow diagonal face; and the chamfering is said to be *stopped* when this face does not mitre round the corners, but finishes a little short of them, to avoid weakening the junctions. As this mode of finish is suggested by, and springs from, the nature of *wood-work* itself, of course it was the general mode in times of rational architecture, and disappeared simultaneously with the appearance of the sham stonework pedantries, at the rise of "Renaissance," and counterfeit work of all kinds. The carriage-makers, farther from the corrupting influence of dilettanteism, preserved this bit of truth to our own day, so that it now appears in railway carriages, but in no buildings, except as a means of affecting mediœvalism in churches. Carved terminations to such chamfers would afford scope for any degree of total ornament or cost, from the lowest up to the highest now spent on the supposed ornaments about to be described; and this with far more *concentration*, *variety*, and *interest*.

Bead and flat, is when a flat panel is surrounded by a bead, or three-quarter cylinder, wrought on the

projecting stiles and rails. It produces too much play of light and shade to be much tolerated by English taste.

Ovolo and flat, a convex moulding, whose section is a quarter circle or quarter oval, surrounding a flat panel.

Ovolo and raised, the same round a raised panel.

Ogee flat, or *ogee and raised panel*, a moulding of contrary flexure, instead of one only convex.

Quirk ovolo, or *quirk ogee*, &c., when the curve of either of these mouldings returns inward, after its greatest projection forward.

The general term *moulded* will apply to the four last finishings, or to any in which these mouldings are combined, to whatever extent.

The description of any piece of panelled framing, as a door, &c., may thus be given by describing each side separately, as in the abbreviations about to be proposed.

It should here be remarked that the design of our modern panelled doors is entirely fallacious. If we look at the ends sought in the framing of a door, we must at once see that it calls (no less than a crane or a field gate) for at least *one* diagonal piece, as long as possible; and it would never occur to any one to *suppress* this feature, except for some absurd affectation or mimicry. Further, the natural subordination of the mere filling parts to the more important ones, would cause, in every unaffected door (whatever its mode of construction—panelled, ledged, &c.) the grain of the various pieces to be mostly (or entirely, except in the outer frame or margin,)

diagonal; as we see in old church doors, and even those of modern barns and outhouses in rural places. Again, the panelled construction is properly only adapted to internal doors, for external ones should present, outwards to the weather, as little lodgment, and therefore as smooth a face, as possible; and the natural ornament or relief to the baldness of such a face is obviously furnished by the hinge attachments and other metal work. There is nothing peculiar to *mediœvalism* (as architects seem to think) in making useful things ornaments, or in decorating *without any diminution of material efficiency* in the things decorated. This is no "Gothic" peculiarity, nor anything peculiar to a style; but is common and *natural* to honest men, from Greece to New Zealand, and "from China to Peru." What is strange and peculiar is not this, but the *modernism*, or rather the modern Anglicism, of sacrificing part of the utility of all necessaries for the sake of hiding, or as nearly hiding them as possible,—injuring their efficiency, to make it seem you are without them,—and then ransacking the past and distant, for "*features*" and "*effects;*"—going out of your way to produce baldness (absurdly called *plainness*), and then sticking on, to relieve the baldness, sham features, that can only excite the ridicule of the intelligent universe.

In doors moulded on both sides, the grooves for panels must be ploughed deeper than the moulding, to prevent light shewing through the mitres, should the deals shrink; but if framed with a square back there is no necessity for ploughing so deep.

As the mouldings, however, are now seldom really

part of the work, but imitated on strips of wood stuck on afterwards, the above rule seldom applies.

The joints of panels should be ploughed and tongued.

All tongues should be cut across the grain of the wood.

ABBREVIATIONS.

The same observations respecting abbreviations will hold good, but to a greater extent, with the carpenter and joiner than any of the other trades; and even the most complicated, as sashes and frames, which may appear at first unintelligible, will very soon be read with as great facility and equal accuracy, with all their varieties, as could possibly be if written at full length: viz.

FOR TIMBER.

L N O	Labour and nails only.	Ro & L	Rough and Labour.
L^{r} to Q^{r} P^{ns}	Labour to Quarter Partitions.	W	Wrought.
		F	Framed.
Fir or Oak. { Ro	Cube Fir rough.	B	Beaded.
Fir or Oak. { Bnd	Bond.		

EXAMPLE.

C Fir, W, F, R, & B . Cube Fir, wrought, framed, rebated, and beaded.

FOR DEALS, after describing their thickness.

Inch deal R	Inch deal rough.	D	Dovetailed.
E S	Edges shot.	F	Framed.
W 1 S	Wrought one side.	K	Keyed.
W 2 S	Wrought two sides.	M & C	Mitred and chamfered.
G	Grooved.	S	Sunk.
B	Beaded.	P	Plugged.
P T	Ploughed and tongued.	L	Ledged.

EXAMPLE.

Inch deal, W 2 S, F & B	Inch deal, wrought two sides, framed and beaded.
Whole deal, W 1 S, P T	Whole deal, wrought one side, ploughed and tongued.
1½ deal, W 2 S, M & C	1½ deal, wrought two sides, mitred and chamfered.

DOORS.

R, G & L	Rough, grooved and ledged.	O R P	Ovolo raised panel.
W, L, R, B	Wrought, ledged, rebated, and beaded.	Q O B	Quirk ovolo and bead.
S	Square.	O G	Ogee.
B, B & S	Bead, butt and square.	Qᵏ O G	Quirk ogee.
B Fʰ	Bead flush.	Qᵏ O G B	Quirk ogee and bead.
B Fᵗ	Bead flat.	O G F	Ogee flat.
B S	Both sides.	O G R P	Ogee raised panel.
O Fᵗ	Ovolo flat.	D M	Double margin.
		B M	Broad Margin.

EXAMPLE.

1¼ Dᴵ, W L, R & B door	Whole deal, wrought ledged, rebated and beaded door.
1½ Dᴵ, 4 P, Q O G & B, & B Fʰ door.	One and a half inch deal, four panel, quirk ogee and bead, and bead flush door.

FLOORS.

Inch W D Floor F	Inch white deal floor, laid folding.	Ro, E S	Rough, edges shot.
		W F	Wrought, laid folding.
1½ Y D, R F Floor	Inch and half yellow deal, rough folding floor.	W S J	Wrought, straight joint.
		D	Dowelled.

EXAMPLE.

1¼ inch Y deal, W S J floor, H J P T, E N	1¼ inch yellow deal wrought straight joint floor, heading joints ploughed and tongued, edges nailed.

SASHES AND FRAMES.

D C frames, O D S sills, W P P, B & P S, 1½ W a & h Sashes, D h, B P, P L & L weights.	Deal case frames, oak double sunk sills, wainscot pulley pieces, beads and parting slips, 1½ inch wainscot astragal and hollow sashes double hung, brass pulleys, patent lines, and lead weights.

Any variation from this description may be made with ease; viz. if

I B P	Iron box pulleys.	M P P, B & P S	Mahogany pulley pieces, beads and parting slips.
B A P	Brass axle pulleys.		
S H	Single hung.		
C W L	Common white line.	D P P, B & P S	Deal pulley pieces, beads and parting slips.
I P	Iron pulleys.		
I W	Iron weights.		

ON MEASURING CARPENTERS' WORK.

There are two methods of measuring carpenters' work: one by taking the superficial contents of roofs, floors, partitions, &c., at per square of 100 feet for the labour and nails, and then the cube contents of the timber without labour. The other method is, by measuring the cube contents of the timber as cube fir and labour, framed, &c. &c.

If the scantlings of the timber are small or light, it will pay the carpenter best to measure the roofs, floors, &c. as labour and nails, and the timber as no labour. But if the scantlings of the timber are large and heavy, then it will be more to his advantage to measure the work as timber, with the particular labour thereon, as follows:—

If the work is measured as timber and labour, the scantling of each piece is taken as cube fir or oak and labour, and entered accordingly; as

Cube fir, or oak, in ground joists, bonds, lintels, plates, &c., labour and nails included.

Do. framed in roofs, partitions, naked floors, &c., labour and nails included.

Do. . do. . . truss framed . . do.

Do. wrought and framed . . . . . do.

Do. wrought, framed, and rebated . . . . . do.

Do. wrought, framed, rebated, and beaded, labour and nails included.

Do. in door-cases.

Oak trusses put into girders, per foot run, stating their size, as 4 in. square, &c.

In measuring for labour and nails to roofs, naked framed floors, ceiling floors, quarter partitions, or any other rough framed work, the dimensions should be taken from the extreme ends of the timber each way, to ascertain the superficial contents thereof, as labour and nails at per square of 100 superficial feet. The openings to chimneys, staircases, &c. are not to be deducted, as the trouble of framing the trimmers and the joists into those openings is fully equivalent to running the joists through them. The same rule must be observed in taking the labour and nails in quarter partitions, as doors, &c., which must be entered in the measuring-book and valued according to the description of the work, as follows :—

For Roofs.

Labour and nails to common shed roofing.

Do. . do. with purlins.

Do. . do. with purlins and struts.

Do. . do. common span or valley with purlins and rafters.

Do. . do. span with collars, dovetailed into sides of rafters notched to receive purlins, filled in with common rafters.

Do. . do. framed with principals, king posts, two struts and purlins, filled in with common rafters.

Do. . do. . . do. with king and queen posts.

Do. . do. common kerb roof.

For Floors.

Labour and nails to fir ground joists, bedded and not framed.
Do. . do. pinned down on plates and framed to chimneys.
Do. . do. single framed floors, trimmed to chimneys and stairs.
Do. . do. with girders and cased bays.
Do. . do. framed floors, with girders, binding, bridging, and ceiling joists.
Do. . do. to common framed ceiling floors, with binding and ceiling joists.

Quarter Partitions.

Labour and nails to common 4 in. quarter partitions.
Do. . do. . . 5 in. do.
Do. . do. . . 6 in. do.
Do. . do. truss framed with king posts.
Do. . do. . do. with king and queen posts.
If oak is used, describe it.

Having taken the labour and nails, you must then proceed to take the timber therein, which must be entered as cube fir, or oak, without labour.

In roofs, it is customary to take the highest timbers first, as the ridge piece, hips, &c., next the rafters, and so proceed downwards to the ceiling floor.

In partitions, floors, &c., begin with the timbers of the largest scantlings. Wherever a tenon is made, the length must be taken from the ends of the tenon, and not from the shoulders. Likewise the length of joists, including the part in the wall.

In measuring king and queen posts, take the whole length by the scantling of the shoulders. The parallel pieces sawed out for the abutment of the principal rafters must be deducted, should they

exceed two feet in length and 2½ inches in thickness; but taken five or six inches short of the length between the shoulders, as the saw cannot enter with much less waste. But if the pieces are less than 2½ inches thick, no deduction must be made, they not being worth more than the labour of cutting them out.

ROOFS.

Hips and valley to be taken at per foot run, for cutting and waste.

All plates, lintels, discharging pieces, to be taken as bond timber.

Gutter plates, diagonal ties, dragging pieces or braces, struts, and tie-beams, as fir framed.

Deduct half the length of bond timbers running through openings.

Allow the length of dovetails or scarf in bond timber, but only taken as bond timber.

Fixing iron straps, screw bolts, hanging ditto, and all iron-work, to be taken and allowed extra.

FLOORS.

Oak trusses, let into breastsummers, to be taken at per foot run.

Oak king or queen posts, let into breastsummers, each at ——.

Girders sawed down, reversed and bolted, per foot run extra.

Letting in screw-bolts, plates, &c., each extra.

Common or herring-bone strutting between the joists, per foot run extra.

Furrings to ceilings, quarter partitions, battenings to walls, &c., are measured by the square, including labour and nails, and valued according to the thickness of the deals used, from $\frac{3}{4}$ to 3 inches thick. Describe the battening either as framed or nailed only, or if plugged, or if with horizontal backings.

All wall-hooks and holdfasts to be allowed extra.

Centering to groins, vaults, recesses, &c.—Take the depth by the circumference for the superficial dimensions, which is valued at per square for use and waste, materials and time. If taken in this way, the whole of the vaults or recesses must be taken, although the same centering might have been used. But where there are a number of vaults or recesses of the same size, the fairest way is to allow the whole of the materials and time, or, if any trifling alteration only is wanted, to allow the time expended in doing it.

If to small openings, as windows, recesses, doors, &c., they may be measured at per foot superficial, viz.:—

ft.	in.	ft.	in.	
3	6			
0	4			Superf. of centering to apertures, as windows, &c. (Plate 3, fig. 1. A.)
12	10			
0	9			
16	10			Superf. of semicircular centering to revealed windows. (Plate 3, fig. 2. B.)
1	10			

ft.	in.
8	2
4	1
0	7
12	10
10	8
5	4
0	10
16	10

Bracketing to cornices. (Plate 3.)—To be measured at per foot superf., according to the girt, viz., 24½ inches by the length, as whole or 1½ inch deal, according to the thickness of deals used. Some allow the bracketing the same girt as the cornice.

inches.
6
1½
9
6½
1½
24½

Cradling for entablatures, measured and charged per foot superf., according to their thickness.

All circular bracketing, cradlings, &c., to be charged double those of straight work.

Ashlering at per foot superf., according to the thickness of the deals used.

ft.	in.	ft.	in.	
20	0			Supposed length } (See Plate 3, fig. C.)
2	0			Height . . . }

Gutters and bearers. (Plate 3, fig. C.)—Measure the length, then the breadth of the bottom and half the eaves-board.

Gutters between the roofs having two eaves-boards, one on each side, take for the width of gutter one of them. (Fig. D.)

ft.	in.	ft.	in.		
20	0			Supposed length	Enter them as— Superf. of whole deal gutters and bearers.
1	1½			Width, (fig. C.)	
20	0			Do. (fig. D.) .	
1	6				

Arris or fillet gutters per foot superf.

Water trunks per foot run; describe size, and allow for laps and half the length of shoe.

Sound boarding.—Measure the dimensions between the joists at per foot superf.; observe if single or double fillets.

Chimney grounds, per foot superf. (Plate 3, fig. E.)

ft.	in.	ft.	in.	
4	6			Enter them as 1½ inch framed grounds, or the thickness, as the case may be.
4	0			
3	9			DD^t. opening.
3	3			

Or they may be taken as—

	ft.	in.	ft	n.	
2)	3	9			
	0	4½			
	4	0			Framed grounds.
	0	9			

If the side grounds are very narrow, framed only for small mouldings, take them by the foot run, and enter them as narrow framed grounds.

Hinges to be numbered and described.

Skirtings, either plain or raking, taken at per foot superf.

If raking, to be taken for the width as per sketch, (Plate 5, fig. B.)

If on narrow grounds, take them per foot run.

If plugged to the walls, allow extra for plugging.

Moulded plinths.—Measure the square part by the length and width, and enter it—Whole deal, wrought one side, rebated and backed plinth. Girt the moulding, and allow half an inch behind the plinth. (See Dado, Plate 3, fig. n.)

Pilasters.—Girt and enter them thus:

ft.	in.	ft.	in.	
7	6			1½ inch deal, glued and blocked pilasters, framed Q^k O G, or ovolo and bead, as may be. (Plate 3, fig. 3.)
2	0			
				Moulded impost ft. 0 in. 6 / 0 3 = 0 9
2	6			
0	9			

The plinth may be measured in with the pilaster.

Flooring. (Plate 2.)—In measuring boarded flooring, the dimensions must be taken, allowing the thickness of the skirting, and valued at per square.

Enter them in your book according to their thickness, and if yellow or white deal, if common or second best or clean deal; if laid folding, straight joint or dowelled.

The slabs are not generally deducted if they have mitred borders; if they have not mitred borders, deduct the opening or slab from the flooring. If the deduction is made when there are borders, the borders must be taken at per foot run, which will amount to as much as the deduction made on the floor.

Mouldings, such as architraves, round doors, windows, &c., base, surbase, &c., &c., are to be measured round the mitres and girt with a fine tape, and entered as moulded architrave, base, &c., as the case may be. But in the abstract they must be all classed under the same head, as mouldings.

Single mouldings, as Q^k O G and bead, or Q^k ovolo and bead, &c., may be taken at per foot run, but their girt must be described, as they will be valued accordingly.

Doorcases, linings, &c. &c. (Plate 4.)—Doors are measured and valued at per foot superficial, according to their description. Solid doorcases are taken at per foot cube.

Door linings, grounds, &c., at per foot superficial as follows:—

Solid doorcases and doors.

ft.	in.	ft.	in.		ft.	in.	ft.	in.
19	2				6	8		
0	9				0	5	7	3
0	5				0	2	7	3
				C O W R & B^{d} Doorcase, (fig. 1.)	3	4		
					0	10		
					0	6	4	8
							19	2

If there is a sill, take it the same as the head, viz., by making an allowance for its passing under and beyond the jambs, as may be; and also allow the additional length of jambs for framing into ditto. If a stone sill, iron shoes should be secured to the bottom of jambs, which must be numbered.

ft.	in.	ft.	in.	
6	8½			W^{h} Deal, 2 S L, R & B^{d} Door, size including the rebates. (Fig. 1.)
3	5			
				Number the bolts, and enter the hinges per pair.

Doors with linings. (Plate 4.)

ft.	in.	ft.	in.		ft.	in.	
6	8			Whole deal 4 P, Q O G & b and B F Doors, (fig. 2, and A fig. 3, 4, 5,) or as it may be. But the door must be taken first between and including the rebates.	6	8	
3	1				6	8	
					3	1	their
		•			0	2	thickness.
				2nd. The linings by calculation . . .	16	7	Twice the
16	7				0	9	width of
0	6½			W^{h} deal, P F R & b^{d} lining, (as B, fig. 3 and 4.)			grounds.
					17	4	One face of
				3rd. The grounds, viz. — Inch deal framed grounds. (D, fig. 3, 4, 5.)	0	8	architrave
17	4						for mitres.
0	4½				18	0	

18	0	4th. Architraves.—Sup^{r}. moulded architraves. (C, fig. 3, 4, 5.)
0	9	
		If mitred and block plinths, number them, but observe to take the architraves short.
		Number the locks, hinges, bolts, &c., describing them.
		Fig. 3 and 4, the common methods for doors in partitions: No. 4 has the preference. Fig. 5, for doors Q O & b^{d} b s in walls, consequently wide linings framed in panels to answer them.

Dado (see Plate 3.)—Elevation and section, showing base and surbase-moulding, plinth, &c., and that the heading joints should be broken, as they are in a straight joint floor. By the narrow grounds K, tongues I, and keys G, the dado hangs unconfined, the joints being also secured by slips ploughed and glued into the back, as at H, and dovetailed pieces inserted at regular distances, as at M, the top and bottom of dado not being confined, and the joints thus secured, there will be no danger of the joints opening, even should the deal shrink. The tongues, I, through the grounds, K, should be about three feet asunder, as also the keys, G; these must be about three inches wide at the bottom. The heading joints should be ploughed and tongued.

B, the common, though bad method of rebating the dado into the grounds.

E, fillet in floor to secure plinth.

F, the best method, by grooving the plinth into floor. The angles of all dados must be grooved.

Measure the height of dado within half an inch of the top of surbase, as it will do for dado and

grounds; then take superf. of moulded base and surbase mouldings; girt the surbase from plastering to face of dado, and the base from dado to top of plain plinths; then add half an inch for rebate. Enter the dado according to its description, viz.—

As inch deal keyed dado.
Do. dovetailed at the back, with grooved rail, or as the case may be.
Do. do. raking.
Do. do. circular on the plan, grooved and backed on the cylinder.
Do. do. wreathed. Number each external mitre.

Sashes and frames, shutters, and fitting up to windows, (see Plate 4.)—Take the dimensions from the beads of sashes on the inside, and allow seven inches additional height for head and sill, and eight inches in width for frames in common sashes; but nine inches for large sashes.

ft.	in.	ft.	in.		ft.	in.
9	1					
4	10			(Fig. 7.) D C F, O S sills, W P P, B & P S .	8	6
					0	7
					9	1
				2 in. W, A & h, S S L, B C P, P L, L W .	4	2
					0	8
					4	10

French sashes, hung on hinges, or sashes hung on centres in solid frames.—Take the sashes separate, and the frames as directed for doorcases. If Venetian frames describe them as such.

If mouldings up munten, take them per foot run.

If circular heads, take the sash by itself, and the frames as run of circular frames, as per description; viz., with beads, parting slips, &c. &c., as may be.

Window shutters are taken per foot superficial, allowing for the rebates.

Number the sash fastenings, locking bars, spring latches, hinges, &c., &c.

The framed grounds, rebated and beaded boxings, linings, moulded architraves, &c., are taken per foot superficial, similar to the doors, viz.—

ft.	in.	ft.	in.	(Fig. 8.)	ft.	in.	
2) 8	8						
0	11			1½ D[l]. 4 Pan[l]. Q O b & b b shutters, E, hung in two heights,	8	6	top and bottom bds.
					0	2	
					8	8	
2) 8	8			Do. back flaps, F.			
0	9½						
2) 8	8			Inch deal, do. do. G.			
0	6½						
				N. 4 pair 2½ butts.			
				8 pair back flap hinges.			
				1 locking bar.			
				2 brass knob spring latches.			
				1 patent sash fastening.			
2) 8	10						
0	10½			1¼ deal, 4 panel, b b, back lining, H	8	8	
					0	2	
					8	10	
4	10						
0	11			1¼ deal, Q O & B soffit, (fig. 6, I.)	4	2	
					0	8	
					4	10	
6	2						
2	6			1¼ deal, 3 panel, Q O b backs and elbows, (fig. 6 and 7, K.)	4	4	
					0	11	
					0	11	
					6	2	
4	4			Run of slit deal, beaded capping to back.			
				No. 2. Caps and elbows.			

ft.	in.				
2)11	2				
0	5				
		1¼ deal splayed and framed boxings, (fig. 8, L.)	8	8	
			2	6	
			11	2	
5	2	1¼ deal framed gro nds, (fig. 6, N.)	4	4	
0	5		0	10	
			5	2	
		Moulded architrave, M.	11	2	
			0	6½	width of architrave.
27	5		11	8½	DDt. ht. of plinth.
0	9	1 pair of mitred and blocked plinths, 8½ in. high.	0	8½	
			11	0	
			11	0	
			4	4	width of architrave.
			1	1	
			27	5	

If boxings are executed, as shewn at L, (fig. 10,) they must be taken as splayed, framed, rebated, and beaded boxings, per foot superf., and the mouldings forming the architrave at per foot run.

Staircases (Plate 5) are taken per foot superficial, by girting the riser and tread by the length of the step, allowing extra for the thickness of the skirting, which is entered in the measuring-book according to their thickness and description, viz., inch deal common steps, risers, and carriage.

1¼ inch deal second best, steps, risers, and carriage, with moulded nosings, close or cut string; or,

1¼ inch deal second best, S R & C M nosings, mitred to receive brackets or string boards and return nosings, and dovetailed to receive balusters.

1¼ inch clean deal, do. do.

1¼ inch clean deal, S R & C, to geometrical stairs on a circular plan, the risers mitred to the string board.

Method of measuring Steps, Risers, and Carriage.

ft.	in.	ft.	in.	
3	6			Length of tread.
1	5			Supr. 1¼ deal, S R & C to fliers, (fig. B and C.)
				ft. in. 0 10 / 0 7 / 1 5
				If geometrical winders, (as plan A,) consequently wrought and blocked carriages, (as fig. F and G,) they must be taken thus, and described as such :—
7	2			Winders with circular ends. (Enter description.)
3	9			
27	10			Risers, the lengths collected . . . . .
0	8			ft. in. 0 7 Project. / 0 1 of nosing. / 0 8
1	2			DDt. opening.
1	6			
9	6			Whole deal framed string.
0	10¾			
4	4			Whole deal apron, 2 sides, (fig. D.) } Return
0	9			¾ do. ploughed in, (fig. E.) . . } landing.
4	4			
0	4½			
				N.B. All winders must be taken as before described.
				Fig. F, shews a single wrought and blocked carriage for a geometrical winder; G, a set of do. as fixed; the dotted lines shew the fronts of steps.
				If moulded return nosings, or brackets, either straight or circular, number them.
				Iron balusters, do.
				Block steps, do.
				Veneered curtails, do. (Plan of do., fig. H, shewing the manner of veneering it; I, section of wedge.)
				Turnings to newels, do.
				Pendent drops, do.
				Handrails, either straight, ramped, or wreathed, per foot run.
				Planceers, newels, bar balusters, &c., do.

ROTATION.

In measuring the carpenters' work of a building, it is usual and customary to begin with taking the roof; then the plates, bond timbers, &c., next the quarter partitions, then the naked floors under ditto.

If it is determined to take the timber in the above without labour, then the labour and nails at per square must be measured as such before the cube timber is taken.

In measuring joiners' work, on entering each room, first take the boarded floors, then the dado or skirting, next the battening or bracketing if any, then the chimney grounds and chimney pieces, next the windows, as sashes and frames, linings, boxings, grounds, architraves, &c., and last the doors, linings, grounds, architraves to ditto, &c. &c.

ABSTRACTING.

In abstracting carpenters and joiners' work, the greatest possible care must be taken to prevent confusion, for when several thousand dimensions have to be entered under their respective heads, unless a regular rule be observed in drawing out the abstract, and placing every description of work in the situation usually allotted to it, much time would be consumed in referring to the different heads.

Proper attention to the form here given, for abstracting the quantities and bringing the different articles into bill according to their regular rotation, will prevent the student from experiencing this inconvenience.

The abstract for carpenters and joiners' work should be made on very large paper, and care taken to give sufficient length in each column for all the dimensions that it may be requisite to enter in them. The deals, as shewn in the lower range, should be put on the other side or on another sheet of paper, under their respective thicknesses. The partitions, backs and elbows, soffits, dados, columns, pilasters, stairs, strings, gutters and bearers, &c. &c., should be placed. It is also better, in abstracting the work of a large building, to keep the ironmongery on another paper, as every care should be taken to keep all the articles and entries separate and distinct.

ABSTRACT OF CARPENTERS AND JOINERS'

Abstracted with Mr. X. Y. Z., January 1st, 1843.

PER SQUARE.																	
LABOUR AND NAILS.			FURRINGS AND BATTENINGS.			BOARDING.		FLOORING.			OAK.		
Qr. P.	Roofs.	Floors.	⅜ in.	2 in.		Ro.	Weather	White Inch.	Yellow Inch. Ro.	Inch Wrot. Foldg.	Cube No labour	Plank 1 in.	2½ in.
			1 in.	2½ in.		W 1 S							
							Sound.				Do. labour	1½ in.	3 in
			1½ in.	3 in.		W 2 S							
								1½ in.		1½ in. Wrot. S J			
									1½ in.		Wrot.	2 in.	4 in.
											Wrot. and framed		

SLIT DEAL.			⅜ IN. DEAL.			INCH DEAL.			1¼ IN. DEAL.			1½ IN. DEAL.		
Ro.	1 S	2 S	Ro.	1 S	2 S	Ro.	1 S	2 S	Ro.	1 S	2 S	Ro.	1 S	2 S

Work done for A. B. by C. D.

	Fir.		Window Shutters.	Doors.	Sashes.	Frames.	Sashes and Frames.	Mouldings.	Runs
	Cube No labour	W & F			1½in.Dl. ovolo	D C F O S sill W P P B & P S			
		W F R & Bd.							
	And labour				2 W ovolo				
	Wrot.		Wainscot.	Mahogany					

	2 in. Deal.			2½ in. Deal.			3 in. Deal.			Ironmongery.				
	Ro.	1 S	2 S	Ro.	1 S	2 S	Ro.	1 S	2 S	Screws	Bolts	Hinges	Locks	Rings Sundries

ROTATION

To be attended to in bringing the quantities into Bill.

CARPENTER AND JOINER.

Sqres.	ft.	in.	
			Labour and nails to roofs, according to description . .
			Do. . do. to floors, naked framed do. . . . .
			Do. . do. to quarter partitions . . . . .
			Inch deal furrings, according to description . . . . .
			Do. battenings . . . . do.
			Do. rough boarding . . do.
			Do. wrought do. . . . do.
			Do. weather do. . . . do.
			Inch folding floors . . . do.
			And the other floors, beginning with the inferior and finishing with the best, and so on for any other articles valued at per square.
			Then the cubes, as—
			Cube oak, no labour . . .
			Do. bond . . . . .
			Do. wrought, &c. &c. . . .
			Cube fir, no labour . . .
			Do. bond . . . . .
			Do. wrought and framed, &c., &c. . . . .
			Cube fir, wrought, framed, and rebated . . . . .

Ft.	in.			
		Do. proper doorcases, or any other, according to the work thereon		
		After the cubes, then the work valued at per foot superf., viz.—		
		Superf. of inch oak plank, then the other thickness of oak plank, with the labour, &c.		
		Superf. of $\frac{1}{2}$ in. deal rough, labour and nails		
		Superf. of do. wrought one side		
		Superf. of $\frac{3}{4}$ in. deal, and proceed to the thicker deals, with their labour, as the case may be, commencing with the thinnest, and proceeding in regular succession, according to their thickness and the labour thereon		
		Then the framed work, as—		
		Inch deal square framed partitions		
		Next the doors, as—		
		$1\frac{1}{4}$ in. 4 panel bead flush and square doors		
		Then the windows, viz.—		
		Inch deal bead butt back linings, quirk ogee and bead backs, elbows, and soffits .		

Ft.	in.				
		Shutters—			
		Bead butt back flaps, quirk ogee and bead shutters, &c., &c.			
		Sashes and frames—			
		1½ in. deal ovolo sashes . .			
		Deal cased frames and sashes, according to their descriptions			
		Then—			
		Superf. of mouldings . . .			
		The work per foot run . .			
		Do. numbered			

VALUATION OF CARPENTERS AND JOINERS' WORK.

MEMORANDA.

50 Cubic feet of timber equal one load.

100 feet superficial equal one square.

120 deals are called one hundred.

A reduced deal is 1½ inch thick, 11 inches wide, and 12 feet long.

120 12 ft. 3 in. deals equal 5⅔ loads of timber.

400 feet superficial of 1½ inch plank or deals equal one load.

Planks are 11 inches wide; deals, 9 inches; and battens, 7 inches.

A square of flooring requires—

	Number of 12 ft. boards.
Laid rough	12½
Do. edges shot	12½
Wrought and laid folding	13
Do. straight joint	13½
Do. do. and ploughed and tongued	14

	Number of 12 ft. battens.
One square of wrought folding floor requires	17
Do. straight joint	18

WEIGHT OF TIMBER.

39	cubic feet of	oak	equal	1 ton.
65	„	fir	„	do.
66	„	deals	„	do.
60	„	elm	„	do.
51	„	beech	„	do.
45	„	ash	„	do.
34	„	mahogany	„	do.

CALCULATION, shewing the method of ascertaining the VALUE of a CUBE FOOT of FIR or other Timber from the prime cost prices:—

	£	s.	d.
Fir timber, at per load, say	5	0	0
Carriage (according to distance)	0	5	0
Sawing, on an average	0	10	0
	5	15	0
Waste in converting, $\frac{1}{10}$	0	11	6
	6	6	6
20 per cent. profit	1	5	3½
	7	11	9½

$\frac{£\ 7\ 11\ 9\frac{1}{2}}{50}$ or 3*s*. 0¼*d*. per foot cube.

The constants in the following tables are to be multiplied by the rate of wages for a carpenter per day.

LABOUR AND NAILS TO ROOFS.

At per square of 100 superficial feet.

	Labour. Days.	Nails. s.	d.
To common shed roofs, one story high	.650	2	0
Do. do. with purlins	.800	2	0
If two stories, add	.084		
If three do. add	.169		
Common span or valley, with purlins and rafters, two stories high	1.000	2	0
If three stories, add	.084		
Framed roofs, with collars devetailed into sides of rafters, notched to receive purlins, and filled in with common rafters	1.906	3	6
Roofs framed with principals, king posts, purlins, braces, and common rafters	2.940	4	0
Do. do. with king and queen posts	3.170	4	0
Common curb roofs on one side	1.125	2	0
If two sides, add	.084		
If three sides, add	.169		
If above two stories, add	.100		

LABOUR AND NAILS TO NAKED FLOORS.

At per square of 100 superficial feet.

Ceiling floors, joists only	.584	1	6
Do. framed with tie-beams	.834	1	9
Do. with binding and ceiling joists	1.000	1	11
Ground joists, bedded but not framed	.500	1	6
Do. pinned down on plates and framed to chimneys	.836	1	6

	Labour. Days.	Nails. s.	d.
Single framed floors trimmed to chimneys and stairs	1.050	1	9
If above 9 in. deep, add	.169		
Framed with girders and cased bays	1.700	3	0
Framed with girders, binding, bridging, and ceiling joists	2.500	4	0

LABOUR AND NAILS TO QUARTER PARTITIONS.

At per square of 100 superficial feet.

Common 4 in. partitions	.900	1	3
Do. 5 in. do.	1.050	1	6
Do. 6 in. do.	1.100	1	6
Truss framed with king posts	1.736	1	6
Do. with king and queen posts	2.000		

If oak, extra one-third.

LABOUR ON FIR TIMBER.

At per foot cube.

	Days.
Cube fir bond	.063
Do. framed	.126
Do. truss framed	.168
Do. framed and chamfered	.168
Do. wrought and framed	.210
Do. do. and rebated	.252
Do. W, F, R, and beaded	.294
Do. W, F, R, and D beaded	.336
Do. proper doorcases	.378
Planing fir, per foot superf.	.014

Bond timbers, wall plates, wood bricks, pole and curb, &c., are all to be under the head of bond.

CALCULATION, shewing the method of finding the VALUE of DEALS or BATTENS from the prime cost prices.

	£	s.	d.
Prime cost per hundred of 12 ft. 3 in. deals, say	35	0	0
Carriage, according to distance	0	10	0
	35	10	0
20 per cent. profit	7	2	0
£ s. d.	£ 42	12	0
$\frac{42\ 12\ 0}{120}$ or 7s. 1d. to be allowed in day-bills for each 3 in. deal	0	7	1
In measured work, allow for waste $\frac{1}{10}$	0	0	$8\frac{1}{2}$
	0	7	$9\frac{1}{2}$

In calculating the value of deals in thicknesses, add the value of the sawing, according to the number of cuts.

Every rise and fall of £9 per hundred, will increase or diminish the price of deals as near as possible, per foot superficial, 1*d.* per inch in thickness. This rule will be found sufficiently correct for practice where the quantities are not large; where they are, the exact calculation should be made.

LABOUR ON DEALS, AT PER FOOT SUPERFICIAL.

In order to facilitate the fixing of proper prices for the labour on deals, at per foot superficial, the different descriptions of work which have always been considered of equal value, are classed together, by which the system adopted for valuing the various sorts of labour on deals, will be rendered more

simple and easy; over the column in which is inserted each kind of work of equal value, is placed the decimal which, multiplied by the rate per day allowed for a carpenter at the time and place where the work is performed, will shew the fair and equitable price to be allowed.

	No. 1.	No. 2.	No. 3.	No. 4.
For deals from ½ to 1½ in. thick	.009	.019	.027	.037
For deals from 2 to 3 in. thick	.013	.027	.037	.049
	Edges shot. Plugged. Jacked. Rounded.	Labour and nails. Planing on each side. Grooved. Rebated. Ploughed and tongued. Framed. Battened. Mitred. Scribed. Backed. Throated. Clamped. Beaded.	Cut circular.	Cut standards. Sunk shelves. Scolloped. Ledged. Dovetailed.

BATTENING, PER SQUARE.

	Labour. Days.	Nails. s.	d.
¾in. to 1¼in. 12in. from centre to centre .	.590	2	0
If plugged to walls, add	.170	1	0
Extra for wall hooks.			

WEATHER BOARDING, PER SQUARE.

Rough	.420	2	6
Ditto splayed edges	.680	3	0
Wrought	1.000	3	8
Ditto and beaded	1.255	3	6

ROUGH BOARDING, PER SQUARE.

	Labour. Days.	Nails. s.	d.
¾in. deal, rough	.500	2	6
Do. edges shot	.667	3	0
Do. ploughed and tongued	.750	3	0
Inch deal, rough	.542	2	9
Do. edges shot	.709	3	0
Do. ploughed and tongued	.918	4	0
Whole deal, rough	.584	3	0
Do. edges shot	.750	3	6
Do. ploughed and tongued	1.042	4	0
1½in. deal, rough	.667	3	0
Do. edges shot	.862	3	6
Do. ploughed and tongued	1.167	4	0

DEAL FLOORS, PER SQUARE.

Inch, rough edges shot	.765	2	6
Do. wrought folding	1.180	2	6
Do. do. straight joint	1.500	3	6
Whole deal, rough edges shot	.840	3	0
Do. wrought folding	1.255	4	0
Whole deal, wrought straight joint, splayed headings	1.760	4	6
Do. do. dowelled	3.170	8	0
1½in. deal, rough edges shot	.920	3	0
Do. wrought folding	1.340	4	0
Do. do. straight joint, splayed heading	2.000	4	6
If ploughed and tongued headings, add	.295		
If ploughed and tongued edges, add	.510		
For tongues to edges of boards, add	.840		

BATTEN FLOORS, PER SQUARE.

Inch, wrought folding	1.500	4	6
Do. straight joint, splayed headings	1.792	4	9
1¼in. wrought folding	1.667	6	0
Do. straight joint, splayed headings	2.167	6	3

	Labour. Days.	Nails. s.	d.
Do. dowelled	4.167	10	0
If ploughed and tongued headings, add .	.431		
If ploughed and tongued edges, add . .	.750		
For tongues to edges of boards, add . .	1.250		
If battens less than 5 in., add . . .	.334		

FRAMED GROUNDS, PER FOOT SUPERFICIAL.

	Labour and Nails.
Common framed grounds	.063
1 in. do. ploughed for plastering	.070
1¼ in. do. do. do.	.076
1½ in. do. do. do.	.083

SKIRTINGS, PER FOOT SUPERFICIAL.

Plain skirting	.087
Do. raking cut to steps	.070
Torus skirting	.065
Do. raking cut to steps	.085

GUTTERS AND BEARERS, PER FOOT SUPERFICIAL.

Inch or whole deal	.076

DOOR LININGS, PER FOOT SUPERFICIAL.

Plain single rebated	.056
Do. and beaded	.063
Do. double rebated	.070
Do. do. and double beaded	.077
Square framed jambs, each in 2 panels and soffit in 1 panel	.105
If bead butt, or moulded, add	.013
Bead flush, or quirk moulded	.027
Raised panel and moulded	.042
For every extra panel if square	.021
Do. flush or moulded	.027
If double rebated	.021
If double beaded	.013

LEDGED DOORS, PER FOOT SUPERFICIAL.

	Labour and nails.
1¼ in. rough edges shot	.065
Add,	
If ploughed and tongued	.013
If ploughed and beaded	.021
If wrought each side	.013
If braced	.027
If hung folding	.021
If 1 in. thick	.013

FRAMED PARTITIONS, PER FOOT SUPERFICIAL.

1½ in. square framed	.065
2 in. do.	.076
Add,	
If BB or moulded	.027
If BF or quirk moulded	.042

DEAL MOULDINGS, FIXED COMPLETE.

Common mouldings	.128
Add, if quirked	.028

The materials for mouldings in deal will be found as near as possible of the same value as the labour. Small mouldings may be measured at per foot run, and valued according to the girt and form.

DOORS HUNG COMPLETE, PER FOOT SUPERFICIAL.

Two panel square framed	.070
Add, for every additional two panels;	
If framed square,	
For 1½ in. deal	.019
2 in. do.	.021
2½ in. do.	.027
If framed B B and square,	

	Labour and nails.
For 1½ in. deal	.021
2 in. do.	.024
2½ in. do.	.027
If framed B F and square,	
For 1½ in. deal	.027
2 in. do.	.037
2½ in. do.	.042
If framed Qk. O G and Bd. and square, or Q Ov. and Bd. and square,	
For 1½ in. deals	.021
2 in. do.	.024
2½ in. do.	.027
If double margins 4½ in. wide	.021
Do. 5½ or 6 in. do.	.042
Hung folding	.013

WINDOW LININGS, PER FOOT SUPERFICIAL.

Inch deal two panel square framed back linings	.101
If B B or moulded, add	.013
B F or quirk moulded, add	.021
For each panel above two, if square	.021
Do. do. if moulded	.027
If splayed	.007

WINDOW BACKS, ELBOWS, AND SOFFITS, PER FOOT SUPERFICIAL.

Inch deal, plain keyed or two panel square backs	.085
Do. two panel square backs, elbows and soffits	.098
Add for each panel above three,	
If splayed	.010
If bead butt or moulded	.013
B F or quirk moulded	.021

BOXINGS TO WINDOWS, PER FOOT SUPERFICIAL.

Framed, rebated, and beaded boxings	.101
Splayed F R and beaded boxings	.120

DADOS, PER FOOT SUPERFICIAL.

	Labour and nails.
Proper dado, with dovetailed keys, joints secured with slips, and dovetails hung to grounds by keys grooved into do. and dado	.070
Add,	
If raking scribed to steps	.019
Do. to moulded nosings	.021
If base grooved into floor	.009
For each external mitre beyond two in the room	.228
If circular on the plan,—double the above.	
If wreathed do,—treble do.	

COLUMNS AND PILASTERS, PER FOOT SUPERFICIAL.

1¼ in. deal plain pilasters, properly glued and blocked	.112
Do. do. diminished	.153
1¼ in. deal diminished columns, properly glued and blocked, under 14 inches diameter	.420
Do. do. above do.	.350
Add for	
Arris or deep fluting to pilasters, one inch wide	.021
Do. two inches wide	.028
Do. three inches wide	.042
Arris or deep fluting to columns, one inch wide	.027
Do. two inches wide	.042
Do. three inches wide	.056
Straight grooves to columns	.021
Headings to flutes to do.	.070
Straight grooves to pilasters	.013
Headings to flutes to do.	.042

SAWYER.

The charges for sawyers' work are often very inconsistent, and differ widely in various parts of the country.

The proper mode of valuing the labour on sawing fir or any other kind of timber is by the square of 100 superficial feet, the price depending on the usual rate of wages and the hardness of the timber.

Sawing to old timber is usually charged double, on account of the extra labour occasioned by nails, &c.

Small scantlings may be charged by the foot run.

Planks, deals, battens, and flat cuts, according to their length, at per dozen cuts.

And all other descriptions of sawyers' work may be valued in a similar manner, according to the circumstances of the case.

MASON.

REMARKS ON DESIGN, &c.

It was well observed by Dr. Robison (Mechanical Philosophy, § 554), that the Gothic is the only school of architecture founded on the nature of stone, and rational treatment of stonework (*i. e.* of a building *wholly* in stone, or having that material extended at least beyond mere supports and enclosures, to a self-supporting roof or ceiling). Without this, observe, none of the distinctive Gothic features could have arisen, nor have any meaning. But for the groined ceiling, no buttress with offsets, no panelled "honeycombed" wall, no pinnacle, no flying buttress, no triplet or other grouping of windows, no tracery window, and (as I believe) no clustered pillar or pointed arch, could have entered the head of builder or architect; for there could have been no rational motive to suggest any of them; and modern experience has shewn, that without rational motive such things do not spring up. Mere novelty-hunting and dilettanteism do not evolve permanently admired things like these. Now, even waiving the two last, (as possibly sug-

gested by other reasons independent of the vaulting,) let us ask, without the other features enumerated above, where or what would Gothic architecture be? It would be simply a rational stone architecture, with all its arches pointed, but partaking no more of the character we call Gothic than any other unaffected mode of building that uses stone arches does;—no more than the early Arab, or Indian, or Lombard, or Norman.

The Doctor was mistaken, therefore, in claiming Gothic as the only rational stone architecture, unless by stone architecture be meant building *wholly* in stone, roof as well as walls. He was still further wrong in claiming for it any peculiar right to the title, "rational architecture;" for architecture is not confined to one material, but means the right treatment of *whatever* material we use. He asked, indeed, "Since stone is the chief material of our buildings, ought not the members of ornamental architecture to be refinements on the essential and unaffected parts of a simple stone building?" Certainly they ought, if the premiss were a fact. But *is* stone the chief material of our buildings? No; here the Doctor was deceived by the counterfeit appearances it is the business of modern architecture to keep up. They succeeded so far that he did not perceive all our "stone" buildings were shams—stone being used not for its advantages, but only to keep up appearances: he did not perceive that we have really returned to the age of wood, only have not the honesty to avow it: he thought stone was

sometimes our chief material, because he saw it sometimes made to *appear* the chief, either to conceal impoverishment at any cost, or to evade the necessity of design (rendered unattainable for want of real architects) by rendering a ready-made architecture *apparently* proper.

Observe, that there may be a total difference between the *chief* material of any building and its *most abundant* material. We have more brick (and in stone districts more stone) about a building than any other material, simply because they are our space-filling materials; but, if mere space-fillers, they have no more to do with the architecture than the soil has with which we fill a terrace. The chief architectural material means, that which is depended on, and resorted to, for meeting structural problems, for spanning and covering voids, &c. Now this, I affirm, is in our case *wood*, and wood *alone* (except where the engineers have begun copying carpentry in iron). Hence the inadaptability of the old styles; for in the Egyptian the material corresponding to this was stone alone; in the Greek, a melange of wood and marble; in the Roman, brick and stone; in the Gothic, again, stone only; but in the modern English (as in the Burmese or Malay), wood only.

Whatever the rationalism of the Gothic, then, it cannot be rational *for us* (a proposition, indeed, hardly worth combating, since no man of common sense, looking at a recent church or Tudorism, can entertain, I suppose, for a moment, the idea that adaptation of the materials to their end had any

thing to do with it). Sadly prophetic indeed were the Doctor's next words: "It [Gothic architecture] deserves cultivation; not the pitiful, servile, and unskilled copying of the monuments; *this will only produce incongruities and absurdities equal to any that have crept into the Greek* [Renaissance] *architecture.*" Alas, when will the age overtake this telescopic seer of our grandfathers' time?

The fine natural taste of this only real architect of his time taught him, that the results of one kind of work, copied as ornaments or disguises to another kind, were false art—were a pitiful shuffling substitute for art,—and this, whether occurring in a Vitruvian "authority" or a mediœval abbey,—that they were a kind of art containing the elements of continual decay, and tending to nothing but ever-deepening debasement. He shewed that the defect of structural science in the Grecian masonry arose from their attempts to reproduce in stone some of the "effects" of wooden building. "Here (said he) is surely an error in principle. The principles of masonry, and not of carpentry, should be seen in our architecture [in a stone-constructed architecture,] if we would have it according to the rules of just taste. Now we affirm that this is the characteristic feature of what is called the Gothic architecture. In this no dependence is had on the transverse strength of stone. No lintels are to be seen; no extravagant projections. Every stone is pressed to its neighbours, and none is exposed to a transverse strain."

The Gothic might, therefore, be exactly defined, as I elsewhere shewed, by calling it simply the architecture of *universal compression*, or the COMPRESSILE style—a term that would not apply to any other in existence. And in building *entirely* of brittle material,—as stone, brick, or cast iron,—the style resulting, when everything is duly reasoned out, must be the complete Gothic, and no other.

Now mark the abuse of this. After observing that "the Norman (mediœval) architects frequently roofed with stone;"—that "their wooden roofs were in general very simple; and their professed aim was to dispense with them altogether" (as in Redcliffe Church, Bristol, and in Milan Cathedral, which, Mr. Petit has observed, carries out the Gothic principles in general form more than any other building he knows);—after observing that, "fond of their own science, they copied nothing from a wooden building;"—the Doctor adds, they "ran into a similar fault with the ancient Greeks. The parts of their buildings which were necessarily of timber, were made to imitate stone buildings; and Gothic ornament consists in cramming everything full of arches and spandrels. Nothing else is to be seen in their timber works; nay, even in their very sculpture."

Dr. Robison felt and knew this was base and false art; but he could not explain *why*, at least not so as to be intelligible to men of perverted taste; not so as to shew them that he judged on a consistent definable law, instead of caprice. The clue

to this, and to a thousand similar difficulties, has been furnished by that one golden formula of Ruskin's, which atones for all the inconsistent crudities he has troubled us with, "that all ornament is base which takes for its subject human work, that it is utterly base,—painful to every rightly-toned mind, without perhaps immediate sense of the reason; but for a reason palpable enough when we *do* think of it. For to carve our own work, and set it up for admiration, is a miserable self-complacency, a contentment in our own wretched doings, when we might have been looking at God's doings. And all noble ornament is the exact reverse of this. It is the expression of man's delight in God's work."

This invaluable discovery, which seems as plain as a riddle when told, ties up in one bundle the whole faggot of modern architectural tares,—the whole of what Mr. Fergusson so truly calls the "monkey styles,"—the whole "copyism question,"—and especially that bearing of it which we (who protest against all *adapted* architecture) could heretofore so rarely make an Anglo-Saxon, on either side of the Atlantic, perceive,—viz. how a form that is beautiful on an old building might, when exactly copied, be base and odious,—how what is lovely on Westminster Abbey might be grossly vulgar on Westminster Palace, or what is grand on the Parthenon be ridiculous on a Philadelphian Bank. If a person did not see that the same form which on the old work evinced a man's mind, on the new evinced

a monkey's, we had nothing more to say, no common standing-ground. Now Ruskin's formula makes this a degree plainer, and I should think plain enough. The thing which we copy (say a pinnacle) is, in the old work, a *member*, an organ, a piece of ornamented utility; its general form or design, for material usefulness, is of course a human invention,—or it may be the millionth version, imitation, or, if you will, "copy," of a human invention,—but *it is not set up as ornament.* What it may have of ornament, is abstracted imitation of nature. But the same form copied, as we copy it, is no longer an ornamented member, but simply *an ornament;* therefore an imitation of human work as ornament,—and therefore base, if you accept the above rule. The error arises from comparing it with a similar *form* on the old building; whereas you must compare it with a similar *thing*—something having the same nature and purpose, viz. something purely ornamental. Thus: would you compare the Victoria Tower with something fairly admitting of comparison in an old cathedral, it must not be with a belfry tower. As the former is the largest piece of pure ornament in the Palace, you must parallel it with the largest piece of pure ornament on the cathedral. Now this is commonly a finial on one of the gables. Between these two things, therefore,—things alike in purpose, both ornaments, both imitative, both abstracted imitations (but the one of human work, the other of Divine work), your comparison must be made, as to their relative order of skill shewn in the propor-

tion of thought to manual labour, and of means to end.

The most bulky ornament in Greek architecture was a statue in a tympanum; and in modern Grecisms, the largest is commonly a portico, sometimes (as at Birmingham) a complete peristyle; so that between these the same comparison might be instituted.

I now hope the reader (even though he do not subscribe) will at least see the consistency of objections to *adapted* Gothic. Without coming down to our present adaptations, where tracery-window, pinnacle, and buttress are all mere means of disguise, a mere masquerade dress, to furnish a fashionable excitement, now nearly worn out,—without comparing this with the realities of architecture, however debased,—he will see that much of the detail of the later, or even the middle Gothic,—much, as Dr. Robison said, of "even their sculpture,"—was simply setting up models of their own work for admiration; declaring, in the very house of praise, that there was nothing more admirable on earth than mullions and cusps! And when their timber-work (generally out of sight) was afterwards and in civil buildings exposed, it appeared they were too lazy to do with it what the ecclesiastical masons had done with their stone. So, instead of really ornamenting, they only disguised it with forms of sham-masonry. "Westminster Hall," says the Doctor, "exhibits a specimen of the false taste of the Norman roofs." He observes that the essential parts (themselves so

distorted and absurdly placed, for the sake of this disguise, as to be unable, though extravagantly massive, to keep their designed form,) "are hidden, or intentionally covered with what is conceived to be ornamental; and this is an imitation of stone arches, crammed in between slender pillars, which hang down from the principal frames, trusses, or rafters." (The cumbrous freak was indeed an ominous foretype of our whole after architecture, the most *unpractical* in the world, torn to pieces with the perpetual conflict of its two jarring elements,—disguised construction and constructed ornament,—the body becoming ever more straitlaced, and the dress becoming an artificial body of hoops and starch.) "In a pure Norman roof," (he adds) "such as Tarnaway Hall, the essential parts are exhibited as things understood, and therefore relished. They are refined and ornamental; and it is here that the inferior kind of taste, or the want of it, may appear."

Since the abandonment of the stone vaultings, there remains no vestige of even the minute degree of mechanical science or contrivance for which other stone-work features afford scope. The science of the mediœval masons has hence become a subject for vague declamation and wonder; though it really, as Wren observed, failed in many respects; and the piers of high churches nearly always bend inward with the pressure of the aisle vaulting against the middle of their height. In our "restorations" we might permanently remedy this, by rebuilding them, or their central core, with slightly inclined beds,

sloping outward towards the aisle, till we arrive at its vaulting, and above that sloping the contrary way; thus giving the whole pier, from ground to main vaulting, the property of a "straight arch" set up on end.* Where there are three vaultings of equal height, as in the Temple Church, if "restoration" meant preservation, we might *first* (before bedizening with colour and polish) restore the pillars to their verticality, and the vaults to their designed curvature, and keep them there by applying our algebra to put on the narrow side vaults that additional load which will just equalize their thrust with that of the wide centre one; as the *original builder tried to do*, but could not, for want of mathematics. By a few such obvious and now easy bits of assistance,—a few replacements, not of storied stones, but of dumb mechanism (especially of perished Early English shafts, in Scotch granite),—a few rebuildings, no matter how roughly, of buttresses cut away by modern ignorance,—and covering with lead the backs of flying buttresses (the chief causes, as Wren said, of Gothic ruin),—we might preserve, almost inde-

* That it is practicable thus to rebuild *any* aisle-pier without disturbing the parts supported, was sufficiently proved about forty years ago, by the entire removal of *two adjacent* ones at once, of those in the nave at Winchester, the largest, I believe, in existence, (except at St. Peter's), being Saxon cased over with Gothic work, and girting 30 feet by a stretched line, and bearing probably the heaviest Gothic clerestory anywhere, and the heaviest English vaulting. The timber shoring for such an extreme case was of course very expensive, but perfectly successful.

finitely, many a priceless monument of real splendour, that will otherwise hardly survive ourselves. But it is too evident that *preservation* has nothing to do with the ends of fashionable "restoration." Lying replacements of wantonly destroyed carving (that must, by their repeated forgeries, make the whole book of art-history in this country virtually a blank),—destructive cutting and hanging-on of parasitical facework, — replacements of what has decayed with *invariably the same material, or a worse*, —rebuilding structural failures in *precisely the same form and structure* (alas! how near to monkeyhood we may approach),—trickings out with paint, polish, and paving, and every petty finery that can be invented to make work, and require neither art nor science,—but, worst of all (except destruction), insolent *mimicry of the building's self* thrust in its own face, far worse than the worst classicalisms (for if we *must* have mimicry, in the name of all that is unconfused, let it be mimicry of something distant—something as foreign, as distinct, as "cut out," as possible),—these things taking precedence of all else, even in temples at once almost finished and almost decayed (as Westminster, Ely, Chester), too plainly betray the nature of the "restoration" mania, and justify the indignation it is beginning to excite. Heaven save us some realities! for man will not.

A study of the restoration works of the Gothic masons themselves (not the mere patchings, inser-

tions of windows, &c., but adaptations of a new aisle to an old one, and such like,) would shew that this kind of work was regarded by them as far the most difficult, and calling for most invention. They thought it necessary to keep a general correspondence with the old work in proportions and richness, yet always in their own style, *i.e.* in the manner which their own materials (dead or alive), their own advanced knowledge or their workmen's diminished skill, their altered circumstances or social state, rendered possible and right. There is great inequality in the success of these adaptations, but the best are wonderfully thought out. In one thing I cannot but think they did wrong. In building the second of two fellow-members both visible and conspicuous at once (as two west towers), I should certainly have followed the whole *mechanical* design of the first (*i. e.* all except carving), unless it had shewn structural imperfection, or was meant to be rebuilt. This, I believe, was often the case; and that remodellings, which we see confined to a small part of a church, were intended to be carried all through it. But nothing would induce me to make, on any cathedral, any addition or restoration, great or small, from a door to a nave, (for which there was not *complete* authority), *in any style but my own*,—that which, on due study, I should deem to arise out of the materials, knowledge, and social condition of the present day, at that place, and keeping in view the harmony (not mimic iden-

tity) to be kept with the skeleton form and degree of decoration (not style) of the old work. And I believe any mason of moderate intelligence, pursuing this plan honestly, would do more satisfactory things for this purpose than the first architects of the day following the present system.

Mimic styles I consider only really in place in theatres and shows. Perhaps they might sometimes be endurable as playful freaks in a summer-house, bath, or even villa; but, of all places, the *church*, and of all kinds of work, reverent *restoration*, seem to me the exact place and work from which style mimicry should be most utterly spurned and scouted; instead of making them, as it now does, its strongholds.

Bartholomew observes, that in the mediœval masonry there was very little waste by cutting, indeed hardly any, if the natural irregularities of the stones be well taken advantage of; but the production of "Renaissance" mimicries, and especially of the unmeaning parallelopipeds required to satisfy modern English notions of "plainness," have exacted so much waste, that we now have to allow for it on an extravagant scale, whatever style be mimicked, as the masons, familiar only with "Renaissance," think it necessary to reduce every thing to square forms, preparatory to producing those wanted. Thus the bevelling-off a coping in the mediœval manner (so as best to answer its purpose of throwing off wet, and save material, com-

pared with a flat one of the same height,) can now be done only by a waste both of material and labour: and many similar cases occur; for if thought be economized to the utmost, of course something must be paid in its stead.

As stone-work does not (except in its great triumphs, the Gothic groinings,) involve any technical terms beyond those explained under the head "Brickwork,"—and as its principles of construction are precisely the same, and its rational features (wherever cannot afford vaulting) would be therefore neither more nor fewer than those of correct brickwork, nor need differ from them in any respect except amount and variety of ornament,—we proceed at once to the subjects of measurement and valuation.

ON MEASURING STONE-MASONS' WORK.

There is a variety of opinions respecting the manner of measuring stone-masons' work, both in taking the dimensions for the stone, and also for the labour. It certainly requires more practical knowledge of the operative or working part of the business, than any other trade, to determine correctly between these conflicting opinions. The following rules may be considered sufficiently explanatory of the principle on which the practice is governed or founded.

In measuring cube Portland or other stone; all

stones that are worked square should be taken accurately as they come from the saw to the banker, of course including the parts laid on or pinned into the walls. But as bevelled or irregularly formed stones cannot be converted without more waste than square ones, the dimensions should be taken so as to make a fair allowance for such additional waste, particularly as the solid contents of all the different descriptions of Portland stone, whatever shape the stones may be worked to, are abstracted under the same head, (viz. cube Portland,) and therefore should be of the same value; but which cannot be the case, unless the extra waste in the bevelled stone, &c. is allowed for in taking the dimensions. When this is done, it is only requisite, in estimating the prime cost, to calculate for the waste as if all the stones in the building were cut and worked square. If this method were not adopted, it would be requisite, in ascertaining its real value, to make so many different heads in the abstract for cube Portland, as there are different shaped or bevelled stones, accurately describing each; when the calculations for waste, and of course the price, must vary according to each particular form, the trouble of which would be endless, and without any advantage; indeed, it would come to the same thing, viz., making the necessary allowances for waste, according to the form of the stone. Bevelled or arch stones should be taken about one-sixth above the mean dimension, to allow for waste.

In measuring the cubic contents of spandril steps, some difference of opinion exists as to the best method of taking the requisite dimensions. The following three methods are in common use: viz.,—

1st. Take the length of the step by its extreme width, and by the whole height of the riser measured from tread to tread.

2nd. Take the length of the step by the extreme width from the nosing of the tread to the acute angle, and by half the height of the riser taken from the top of the tread to the acute angle downwards.

3rd. Take the length of the step by its extreme width, and by three-fifths of the depth of the riser taken from the top of the tread to the acute angle downward.

To illustrate these different methods, a diagram is given, Plate 6, fig. 3, shewing the method of sawing two spandril steps out of the same block, by which it will be seen that, allowing half an inch only in each step for waste in sawing and taking them out of winding, the original block must not be less than twelve inches deep; and supposing the extreme length of the step, including the part pinned into the wall, to be five feet, the size of the block will be

5 0
1 3
1 0
—— 6 3;

and each step will therefore contain

5 0
1 3
0 6
——3 1 6.

By method 1st, we have

5	0	length of step.
1	3	extreme width.
0	6	whole height of riser.
——	3 1 6	which is correct.

It should, however, be observed, that if the steps, instead of having moulded nosings, were worked plain, the block would only require to be eleven inches deep, as shewn by the dotted lines, or one-twelfth less than for moulded steps; whilst the rule gives the same content as before, and consequently it should only be applied for the latter description of step.

By method 2nd, we have

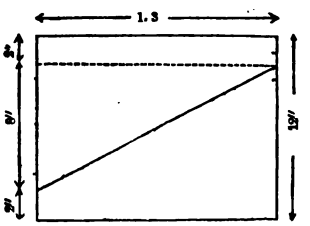
5	0	0	length of step.
1	6	0	extreme width of do. to acute angle.
	4	3	half height of riser from top of tread to acute angle downwards.
———	2	7 10	which is about one-twelfth less than the real content.

By method 3rd, we have

5	0	0	length of step.
1	3	0	extreme width of do.
	5	8	three-fifths of height of riser from top of tread to acute angle downward.
———	2	11 5	which is nearly correct.

A better way than either of the above methods is to take the length of the step by a dimension found as follows, allowing half an inch on each step for waste.

1	3	width of step.
	6	2 base of rectangle.
——		4 half do. of triangle.
		—
		6



This gives

5	0	
1	3	
	6	
——	3 1 6	as before.

In measuring winders, the content may be found in the same way, taking the extreme length of the step by the mean sectional area, making due allowance for waste.

The labour on the under side to be taken as circular sunk work.

All stone exceeding three inches thick should be taken as cube measure, with the labour, &c. on do.

All stones three inches thick, and under, should be taken as slab, at per foot superficial.

The usual custom has been to measure in such edges as are worked, and shew fair. Objections have been made to this practice, and with some degree of justice; but it will make very little difference, if the edges of thin slabs are measured separate, and a fair price allowed for the labour; and for cutting into narrow pieces for mantles, jambs, &c., it would be nearly equal to the value of the stone; but in thick slabs the same argument will not hold good; and, therefore, as the object in measuring work should be to ascertain its real value, and allow only a fair remunerating price, it appears more correct to measure the labour on the edges at per foot run, offering a fair price, according to their thickness, instead of entering it as stone. An extra price should be allowed for very large scantlings, also for hoisting stones on exceedingly high buildings, according to circumstances.

LABOUR ON PORTLAND OR OTHER STONE.

In measuring the labour of working Portland stone, the principal difference of opinion arises in determining what faces or beds should be taken as plain work. Examples are given shewing the methods of taking the labour on different kinds of common work; but in the measurement of superior work, a plain face must be taken previous to measuring the sunk, moulded, or other work, when the mould could not be applied without first making that plain face. There cannot be much difference of opinion in taking the other labour, such

as sunk work, moulded work, circular-sunk or circular-moulded work, &c., which must be girt as it appears when the work is finished, but which is not always the case with the plain work; and therefore it is requisite to know the manner in which the work is executed, to form an accurate conclusion, and to do justice to the workman in its measurement.

ABBREVIATIONS RECOMMENDED.

In measuring stone-masons' work the same rules must be observed in entering the dimensions in the book as directed for the other trades; and the following abbreviations are recommended, for the reason stated under that head:—

C P	Cube Portland.	C W	Circular work.
P W Sup^{r}.	Plain work.	C C W	Circular circular work.
S W	Sunk work.	M W	Moulded work.
C S W	Circular sunk work.	C M W	Circular moulded work.

MEASUREMENT.

STAIRCASES. (Fig. 3, Plate 6.)

ft.	in.	ft.	in.	
5	0			Cube Portland steps, the 5 ft. including that part of the step
1	3	3	1½	that is pinned into the wall, and also the projection of
0	6			nosing.
5	0			P W top { 1 1 tread. 0 1¼ under the next riser. 1 2¼
1	2¼			
4	6			M W front. Girt of moulding, nosing and riser.
0	7			
1	3			M W end. Taken or girt at the average width.
0	6			

ft.	in.	ft.	in.	
0	6			P W to front the part pinned into the wall.
0	6			
5	0			P W to soffit.
1	1			
				[Or the whole flight may be taken in one dimension.]
5	0			S W rebate . . . .
0	4½			No. of steps pinned into wall
				No. of holes cut for balusters.
5	0			
1	3	6	3	Block of stone required to cut two steps out of.
1	0			

ft.	in.	
0	1¼	rebate to front of step.
0	1¾	
0	1¾	do. to back of step.
0	4¾	

Landings. (Plate 6, fig 1.)

13	3	C P Landing . . . .
4	6	
0	6	
2)13	3	P W top and bottom. Here is more plain work than appears, but the plain faces must be made before the joggles are worked.
4	6	
12	0	M W front.
0	7	
2) 0	6	P W to front of landing in the walls.
0	6	
2) 4	6	S W joggles . . . . (Fig. 2)
1	1½	
22	3	Run of cutting . . . .

ft.	in.	
12	0	
0	6	in wall.
0	6	
0	1½	Joggles.
0	1½	
13	3	

0	9 girt of the joggle.
0	4½ do. of the groove for do.
1	1½

13	3
4	6
4	6
22	3

Cut for and pinning landing into wall, which is allowed to be taken through the doorway, &c., for the extra trouble of pinning up the quoins, &c.

Square Steps to Entrance Doors, etc. (Plate 6, fig. 4.)

ft.	in.	ft.	in.	
2) 6	9			C P supposing two steps.
1	1			
0	7			
6	9			P W to bottom step.
1	8			
6	9			P W to top step.
1	7½			
6	9			S W rebate for landing.
0	2½			
6	9			2 in. Portland landing - Portland steps worked to an exact length, and fitted between spandrils, allow one end as plain work.
4	1			No. Plugs.

Coping. (Plate 7, fig 1.)

3	6		C P feather edged coping: 0 3 / 0 1½ / 0 4½ — Nothing extra is allowed for being cut or worked bevel on the face, as it may be done without extra waste.
1	9		
0	2½		
3	6		P W . . . . . : 1 9 top. / 0 3 edges. / 0 1½ / 0 1½ projection over wall. / 0 1½ / 2 4½
2	4½		
1	9		P W to Jts. Allow P W to one joint of each stone, which should average 3 feet in length.
0	2½		
1	9		P W to return of angles where they occur: 0 3 edge. / 0 1½ projection. / 0 4½
0	4½		
3	6		Run of throat, or may be taken at . . . . . : 3 6 / 0 1 M W throat.
			Angle quoins may be numbered as extras; or measure the coping through both ways as common coping, which gives an extra length the width of the coping for the extra thickness, and the trouble of sunk work on the top. Or they may be measured thus :—

ft.	in.	ft.	in.	
1	11			C P quoin, fig. 2 . . . . .
1	11			No. of cramps.
0	3			Pairs of plugs.
				Lead for running ditto.
1	11			S W top.
1	11			
*1	11			P W joint.
0	3			
*3	10			P W outside edge and projection
0	4½			ft. in. 0 3 / 0 1½ / 0 4½
0	4			S W inside angle notched .
0	4			0 1½ inside edge. / 0 1½ projection. / 0 1 throat. / 0 4

String Courses. (Plate 7, fig. 6.)

3	6			C P string course.
1	0			
0	8			
3	6			S W top.
0	2			
3	6			P W . . . . .
0	9½			0 7½ / 0 2 projection. / 0 9½
3	6			Throat S W, or run of throat.
0	1			
1	0			P W to one joint of each stone
0	8			average 3 ft. in length.

Square Plinths worked all round. (Plate 7, fig. 9.)

2	0			C P plinth.
0	11			
0	6			
2	0			P W sides . . . . .
2	10			0 11 / 0 6 / 2)1 5 / 2 10

* In taking the angle quoins of coping, some will allow the plain top to be taken first; but this is incorrect, as there is no occasion to make it previous to sinking the top, being only necessary to bring the stone to its thickness and out of winding, as if for plain work.

ft.	in.	ft.	in.	
0	11			P W top.
0	6			
1	2			S W rebate.
0	4			No. of mortice holes.

Window Sills. (Plate 7, fig. 4.)

4	2			C P window sill.
0	8			
0	6			
4	2			P W top, front and projection .
0	10			
0	8			P W to one end.*
0	6			
4	2			S W top and throat . . . .
0	7			

P W top, front and projection . { ft. 0 2; 0 6; 0 2 } = 0 10

S W top and throat . . . . { 0 6 top; 0 1 throat. } = 0 7

Curbs. (Plate 7, fig. 5.)

6	0			C P curbs.
0	7			
0	6			
6	0			P W including projection . .
1	8			
0	7			P W to one end of each stone, which should not be less on an average than 3 ft. in length.
0	6			
				Take the quoin ends that shew fair as P W.
2	11			C P circular curb. (Plate 7, fig 7.)
0	9			
0	6			
2	11			P W.
0	9			
2) 2	11			C P W.
	0	6		
2) 0	6			S W to arch joints.
0	6			Plugs per pair, with lead; or allow the lead per lb.
				Holes, each.

P W including projection . . { 0 6; 0 7; 0 6; 0 1 } = 1 8

* This is what is usually allowed. Some claim both ends, others measure them thus :—

2) 0	6			P W to projection of ends.
0	2			

Columns. (Plate 7, fig. 8.)

ft.	in.	ft.	in.	
5	5			C P — shaft.
1	5			
1	5			
5	3			C P — shaft.
1	3			
1	3			
1	11			C P base.
1	11			
0	8			
1	11			C P cap.
1	11			
0	8			
2) 5	5			P W — shaft taken two sides.
1	5			
2) 5	3			P W — shaft taken two sides.
1	3			
5	5			Circular work — shaft.
4	6½			
5	3			Circular work — shaft.
3	11			
1	7½			S W to bed for joggle in lower stone.
1	7½			
1	5			P W top bed of upper stone in shaft.
1	5			
1	11			P W top — base.
1	11			
2) 1	11			P W rims — base.
0	8			
6	0			Circular M work — base.
0	10½			

ft.	in.	ft.	in.	
1	11			P W top
1	11			
2) 1	11			P W sides } cap.
0	8			
6	0			Circular M work }
0	8½			

In measuring the circular M work to cap, it should be taken at the average between the angle of abacus and the front.

If the neck moulding is worked in the shaft, the same dimensions may be taken for C P and labour as the bottom stone of the shaft.

Architraves over Columns. (Plate 7, fig. 10.)

3	0	C P
1	7	
1	7	
3	0	P W bottom bed.
1	7	
2) 3	0	M W to fronts.
2	0	
1	7	P W to end.
1	7	
1	4	S W to the joggle.
1	0	
1	7	S W to end, including the joggle
1	11	

ft.	in.	
1	7	
0	2	
0	2	
1	11	

Blockings and Cornices. (Plate 7, fig. 8.)

3	6	
1	6	
0	6½	C P blocking . . .

	0	6
	0	4
½)	1	0
	0	6 ½ for bevel.

ft.	in.	ft.	in.	
3	6			P W . . . . .
3	5¾			
1	6			P W joint, average size.
0	6			
0	9			Run of groove for plugs.
				No. pairs of plugs, and running with lead, per pair.
				If the plain work to bed of cornice, on which the blocking stands, is not taken, it would be allowed to take the bottom bed, which would make it 4 ft. 1¾ in. for the P W.
3	6			C P top bed of cornice.
2	4			
0	8			
3	0			C P bottom bed of cornice.
1	3			
0	5			
3	6			P W beds . . . . .
2	6			
3	0			P W under blocking.
0	9			
3	6			Sunk and moulded work . . . .
3	0			
1	2			Groove run to joints with lead.

ft.	in.		
1	6		
1	7¾		
0	4		
3	5¾		
3	5¾		
0	8		
4	1¾		
1	3		
1	3		
2	6		
1	1		
0	10		
0	6		
0	7		
3	0		

NICHES. (Plate 7, fig. 11.)

6) 1	0 high	C P	Stones in body.
1	3		
0	9		
12)2	6	C P	
1	0		
0	9		

ft.	in.	ft.	in.	
0	9			C P head centre stone.
0	9			
0	4			
3) 2	9			C P arch-stones taken the whole width, on account of trouble in getting them out.
1	6			
1	3			
3) 2	9			P W face of do.
1	6			
6) 2	9			S W to arch joints of do.
1	3			
	1.6			Circular-circular work to spherical head.
3	0			
12) 2	6			P W to bed of stones in body.
0	9			
6) 1	3			Ditto.
0	9			
2) 13) 1	0			S W to arch joints.
1	0			
5	0			Circular work to body . . . .
4	$8\frac{1}{2}$			
14	$8\frac{1}{2}$			S W to front A . . . . .
0	$7\frac{1}{2}$			
10	0			Run of bead and double quirk.
4	$8\frac{1}{2}$			Circular do.
				No. of cramps.
				No. of plugs.

ft.	in.	ft.	in.
3) 3	0	9	0
	$\frac{1}{7}$	0	5
		$\frac{1}{2}$) 9	5
		4	$8\frac{1}{2}$

5	0	
5	0	
4	$8\frac{1}{2}$	
14	$8\frac{1}{2}$	

Stone facings to fronts of houses, if more than three inches thick, should be taken as cube stone, and the face, and one bed and joint taken as P W. Bond stones taken one face bed and joint. If not more than three inches, take them as slab, and one bed and joint as P W. If to circular-headed windows, take the arch joints as sunk work and the soffits as circular plain work, and the straight reveals as P W. If rustics, take them as S W. If stone facings are taken to a parallel thickness, as for old brick fronts, they may be taken as slab even to 4 in. thick, but the P W to beds and joints must not then be taken.

In abstracting masons' work, the paper must be ruled in columns, as before described, observing to place the C P in the first column, and leaving sufficient space in the following columns for the different sorts of labour on do., as P W, S W, M W, &c.; the next columns for Portland slabs, keeping each thickness in a separate column; the next columns for vein, statuary, and other marble; the next for Yorkshire and Purbeck pavings, and other articles of different descriptions; the following columns for articles taken as running measure, and the last columns for those numbered.

WEIGHT OF STONE.

Purbeck stone	.	14 cubic feet	weigh	one ton.
Portland .	.	16 „	„	do.
Bath .	.	17 „	„	do.
Yorkshire	.	15 „	„	do.

Granite . .	13½ cubic feet	weigh one ton.
Marble . .	13 „	„ do.
Purbeck paving .	50 feet superf.	„ do.
Do. step 13 by 6½ .	25 feet run	„ do.

VALUATION OF LABOUR.

TABLE OF CONSTANTS FOR THE DIFFERENT DESCRIPTIONS OF MASONS' WORK.

N.B.—The factor to be applied is the rate of wages for a mason per day.

		Days.
Labour, squaring and laying new York or Purbeck paving per foot superficial		.021
If in courses, add		.010
Labour on Portland or similar stone per foot superficial. N.B. Sawing to be taken as half plain work.		
Plain work to bond stones .	per foot superf. .	.140
Do. to beds and joints .	do. . .	.181
Do. rubbed face . .	do. . .	.209
Do. do. circular . .	do. . .	.291
Sunk work rubbed . . .	do. . .	.250
Do. do. circular . .	do. . .	.313
Moulded work rubbed . . .	do. . .	.292
Do. do. circular . .	do. . .	.417
Circular work to shafts of columns having the neck moulding or part of the base worked in the same stone .	do. . .	.334
Circular circular or spherical work to domes or balls . . .	do. . .	.500
If rubbed, add extra . . .	do. . .	.049
Taking up, squaring, and relaying old paving	do. . .	.042
Add if in courses	do. . .	.015

LABOUR ON STATUARY OR VEIN MARBLE, INDLUDING SAWING, WORKING, AND POLISHING.

Plain work . . .	per foot superf. .	.875
Circular work	do. . .	1.250

		Days.
Sunk work	per foot superf. .	1.667
Moulded work	do. .	2.334
Circular sunk work	do. .	2.334
Circular moulded work	do. .	3.000

ON OLD WORK.

Old vein marble chimney reset	per foot superf.	.	.125
Do. do. squared and reset . . .	do.	.	.167
Do. do. sanded, grounded, and squared .	do.	.	.209
Do. do. and reset	do.	.	.250
Do. do. cleaned and reset . . .	do.	.	.250
Do. do. sanded, polished, and reset .	do.	.	.375
Do. do. sawed, sanded, polished, squared, and reset	do.	.	.626

In the west of England, and all the counties in which stone is abundant, it is usual and customary to build with the rough stone of the country, and the practice generally is to measure the walls by the perch of 18 superficial feet, supposing them 24 inches thick; to which thickness all the walls, whether more or less, are reduced by multiplying the superficial contents by the thickness in inches, and dividing them by 24; or they may be reduced to the cube perch of 36 feet: but some regulate the prices per perch according to the thickness of the walls.

In measuring the work, some contend to girt the quoins and all projections, as they say, to pay them for the extra trouble in working and setting the stones; but this should not be allowed, except for labour only; and even then it is much fairer to measure the quantity of walling as it is, and make a proper allowance for the extra labour, either in quoins, chimney breasts, flues, reveals, &c.

ROTATION

To be attended to in bringing the quantities into Bill.

MASON.

Perch. ft. in.				
	Rough stone walling foundations in random courses, well bonded and flushed with mortar, and grouted with hot lime and sand every two courses			
	Do. do. above foundations, levelled every two feet or height of two quoins, well bonded and flushed with mortar every course . .			
	Superficial of extra labour to external quoins . .			
	Do. do. to internal quoins, &c.			
	Cube Portland, or any other stone valued per foot cube.			
	Superficial of plain work .			
	Do. of sunk work, or such other labour, as the case may be			
	Superficial of 1¼ Portland slab			
	Do. 2 do.			
	Do. 2½ do.			
	Do. of 1 in. vein marble slab in chimneys, &c. . . .			
	Do. of 1 in. statuary marble slabs, in do., &c. . .			
	Do. of Purbeck paving .			
	Do. of Yorkshire paving, &c.; then the runs, as run of Purbeck steps, &c.; then the Nos. as number of holes cut, &c.			

PLASTERER.

REMARKS ON DESIGN, TECHNICAL TERMS, &c.

THE legitimate use of plaster is to produce a smoother, cleanlier, less absorbent and more sightly surface than their natural one, on the faces of walls external or internal, incombustible floors, vaulting, and other roughly finished masonry. Though a mere accessory to building, never self-dependent, and the lowest, as regards skill, among all its industrial branches, yet even plastering has had (as old remains everywhere shew) in times of progress and humanization, something to distinguish it from the work of brutes, some unnecessary beauty or ornament, of its own, springing out of its peculiar properties, and evincing such delight in natural things as was natural to beings made in the image of nature's Architect. But these real decorations have been long forgotten wherever long worship of another and another's image has extinguished this natural mark of human work, and substituted in its place, and with its name, the imitation of whatever has indicated, or been supposed to indicate, the owner's wealth, or been used to counterfeit some-

thing anyhow associated with wealth ;—wherever, in short, ornament no longer means something done for *beauty*, but for *respectability*. As men and nations in this predicament cannot afford to see, or let be seen, the structure (the realities) of their works, and have to employ more trades, and often more labour, in hiding how their work is made, and what it is made of, than in making it, plastering acquires in their buildings an undue importance. Without real ornament of its own, it yet becomes the general means of counterfeiting the shapes of all *features* (ornamented or not) found in the architecture of their betters, past or present. As all these features, when invented, were *structural*, and derived their beauty from studied fitness to what they were meant to do, of course it never then occurred to any one to cover *them* with plaster, but only the plain surfaces ; while monkey art comes at length to reverse this ; so that we daily see buildings with *no* plastering for use or beauty,—none on the *walling*, but all manner of plaster lumps attached, in the forms of stone lintels, brackets, cornices, &c., in positions that would excite great merriment if any one observed them and knew what they represented. And things *ought* to attract some eyes and afford some pleasure, or at least be worth stopping to admire, that are thought worth endangering life by their fall, as appears by more than one or two recent accidents. On one of these indeed we heard that the fall of the object (a cornice-representer) was caused by laying *on its top*, ready to hand, a

series of casts of *brackets*, that were to be stuck on beneath it, to represent respectable support-representers. True or not, the story is characteristic and worth telling.

Internally, though common sense would hardly have attached this heavy non-elastic matter to yielding elastic wood-work, the inability of our architects to make real structure fit to be seen, seems to have long driven us to the present total investiture of *lath* and plaster—a sham building within a building, air-tight, noisome, not to be touched, cracking, left to the mercy of a little water, or a shake, or a loud noise. To this cuticle are stuck, under the notion of ornament, masses representing the same things as those without. An English architect has amusingly described his difficulties in getting all this reproduced to feast the eyes of an expatriated countryman at Canton—a place that does not yet understand "Renaissance," and seems hardly ready for its Inigo Jones. In vain were coupled column and Doric entablature profiled after the purest Palladian rules; daily some (to him) ludicrous blunder stared him in the face. This was mitred, that ought not to have been,—or, that member "cut into" another, and betrayed that they were not naked stones. But when all this elaboration had to be crowned by the blank anti-climax of a "blocking-course," it was too much,—Achone and his men could leave the architect his province no longer, but took his work into their own hands, and launched forth into "flowery decoration,"

that it quite grieved our civilizer of China to have to abolish. (I hope he copied some "Select Examples for the Use of Designers.") The interior once finished, however, its Palladian features, with great trouble made quite correct, fell from ceiling and wall; while the "quaint sprigs, birds and fishes," made by the workmen "out of their own heads," (like revered mediœval examples) indurated to perfection. Poor Achone! poor Inigo Would-be! how little ye understood one another. I wonder which was the barbarian.

As the *ceiling* is the chief member of building which, since this perversion of plastering, has become associated with that craft, let us here consider a little the meaning and rational treatment of ceilings. They are of course not *necessary* parts of building, and Dr. Robison ("Mechanical Philosophy," vol. i. § 554.) defines their use to be "only to keep off the dust." But the keeping heat *in*, or *out*, is certainly another reason for having two distinct coverings, and an intermediate mass of air, interposed between us and the sky, in every climate, rather than any single solid layer, however thick; air being a worse conductor of heat than any roofing material. A third reason, in the mediœval (and perhaps some ancient) temples, and other noble buildings, was to cut off the chance of firing the roof from below, or the supply of air to it, if set on fire; but this of course does not apply to our modern ceilings, dependent on combustible bearers, like the roof itself. There is yet another important

though unnoticed use of ceilings, however, which I will endeavour to explain.

England has for some time been ringing with talk—talk—talk, about the causes of unnecessary disease and mortality, of which *the chief*, as many believe, is foul air in buildings,—*i. e.*, air retained after it has been once breathed. As it has been known for about eighty years that the same air cannot be breathed a second time with impunity, it seems odd that our dwellings should still be constructed so as to retain it as long as possible, and mix it as thoroughly as possible with all fresh air that enters. But so it is; and if these were the ends proposed, architects might be challenged to contrive any thing better adapted to secure them. Every breath of respired air that leaves us, rises, we know, by its own levity,—the only conceivable power by which it could be kept from immediate mixture with what we inhale next—the only power by which it can be removed out of our way, out of doors or in. It rises, then, till it meets with a ceiling, generally an air-tight level horizontal surface. It is instantly spread out into a thin layer,—cooled down to the general temperature (at which it is *heavier* than pure air) as rapidly as possible,—broken up and displaced by the next warm breath that follows it,—and falls back to be breathed again, and circulate again and again in the same round. The openings by which air enters and leaves the place, may be abundantly—*always are abundantly sufficient*, both for the entry of all that

is needed, and the exit of all that is fouled, *if we could only get it there.* But how is it to be got there, till it has lost, by cooling, all its natural power to escape of itself, and been mixed throughout all other air in the room? What steam-power, what fan or furnace, or Victoria Tower or Clock Tower draught that Dr. Reid could contrive, is to extract it from this mixture once made? or to give us a single mouthful of unpolluted fresh air in a room provided with this arrangement for instantly polluting all that enters?—with this inverted sump for light fluids—this undrained receptacle for breath, that keeps it safe till it can be kept separate no longer, and then sends it back to mix inseparably throughout the room. What is the use of "ventilators" hanging down like bosses, or with surrounding rims protecting them from all *drainage* of the surrounding surface?—gaping like Tantalus for a layer of fluid that never reaches down to underflow their lips; for ere it accumulate to half an inch deep from any ceiling, it must either have drained off up the slope, or if there be no slope, have cooled and been replaced, and sent back whence it came. What is the use of "ventilators" in one or more divisions or "coffers" of a ceiling? (divided into such receptacles apparently to keep the poison, during its refrigeration, more safely, against all draughts or lateral disturbances). Or what is the use of them at all (except for the persons immediately under them) in level surfaces? from which the light air can no more *run off*, than heavy

fluid can run off Trafalgar Square, their inverted counterpart.

The foul air, the great self-imposed scourge to be got rid of, has inherent in it, while still warm (*not longer*) a motive power providentially lodged in it, sufficient (though only *just* sufficient) to effect its own escape, if not hindered, and of course to draw in fresh air in its room, if *that* also be not hindered (which it never is)—for without this replacement of course the light air could not escape. It seems odd, then, that there should be any necessity for "ventil*ation*" (air-*carrying*), when we see that it only awaits permission to carry *itself*, and has all the power to do so, if we would only *let* it—if we would only so build as *not to prevent* its natural escape and replacement. Would it not be better for architects *not to make* the mischief, than for Reids and Faradays to be taxed with the impossible problem of *curing* it? I say impossible, for the laws of nature, as far as at present known, afford literally no remedy. No mechanical power (and no available chemical one, but that of the green forests,) can separate fresh and foul air once allowed to mix. A breath which has once knocked at the ceiling for dismissal, and been refused, can never be removed by the ventilation doctors, till the whole air of the place has been changed.

As our difficulty, then, is like Mahomet's—as we cannot, against natural laws, get the foul air to the provided outlets, but must bring the outlets *to it*—a roof without a ceiling affords no means of letting

this refuse *out*, without letting the rain *in*. But a ceiling may be so formed as to let it through without hindrance, and yet prevent its return when cooled; and thus oblige its exit into the open air by *side* openings *between* the two coverings, or between the ceiling and the floor above. Two distinct coverings, then, there *must* be, wherever the two ends of keeping out rain and letting out breath are to be fulfilled. The former is the function of a roof, the latter of a *ceiling*. Thus this member is not, as Dr. Robison said, "only to keep off dust;" but, if sanitary reform be anything but a canting cry,—if unnecessary death and disease be things for which any are to account,—if the suppliers of dwellings are answerable for enconomizing at the cost of life,—if they have any duty, in building for others (as Israel in building for themselves), to "make a battlement for thy roof, that thou bring not blood upon thine house, if any man fall from thence,"—in short, if any man be responsible for human life wasted by human agency,—if "at the hand of every man's brother" shall be required "the life of man,"—then is this part of every building to be contrived according to whatever our latest science may prove necessary to the free passage of light fluid through it from below, and its retention above when once through.

Taking this, then, as the primary function of all ceilings, we see that their form can no longer be lawfully made matter of fancy *alone*. (Indeed I cannot see that they have gained much even in an

artistic point of view, since being made so.) Their form must, in the first place, be such as to have complete *upward drainage*, so that light air rising to *any* part of their surface may find immediate unobstructed way, by its own levity, to an outlet; in short, so that if the whole were *inverted* and rained into, it would drain itself, and retain no water anywhere; or so that if the room in its actual position, without a floor, were sunk in water like a diving-bell, the water would rise and fill it, to the exclusion of every bubble of air. Next, it can have *no portion whatever of horizontal surface*, or of any approaching within a certain angle to horizontality. But as this and other requirements may be deduced best from a comparison with the analogous case of drainage (which is the same thing to *heavy* fluid refuse as this to *light* fluid refuse), I will enumerate first their resemblances, and then their differences;—first reminding the reader, that as a sump or cesspool is a convicted and sentenced manslayer, because what it receives in a heavy non-elastic form, presently loses the weight that carried it there, and comes back to us light as air, volatile and unmanageable; so the *inverted* sump overhead is equally a manslayer, because what it receives in a form lighter than common air, presently loses the buoyancy that carried it there, and comes back to us as heavy as common air, and thus unmanageable. And this is many thousand times quicker in losing its buoyancy (*i. e.* cooling) than the other refuse in losing its weight (*i. e.* evapo-

rating). Both require *drainage* of their contents; the one to be quickly drained off *downwards*, the other still more quickly *upwards*, before they have time to lose the forces (*weight* in one, *levity* in the other,) which, given them for their removal, only serve in misconstructed places to retain them. The resemblances, then, are these:—

1. In draining a space which is liable to receive descending fluid at every part of its area (as a roof exposed to the rain), the drains and the slopes leading to them must occupy the whole surface, so as to leave no portion horizontal. Similarly, to let out foul air, which rises (or is liable to rise) against every part of a ceiling, the vents and the slopes leading to them must occupy the whole.

2. The slopes and outlets of liquid and aeriform refuse alike call for smoothness, even polish, if possible, to lessen friction and disturbance of the currents.

3. Drains must not be too large; neither must the entrances to air-outlets—though for a different reason, viz., that the currents collected to them from all around, may, by uniting in a small space, form a sufficiently rapid and steady flow to resist sudden disturbances, and, by well filling up the aperture, leave no room for counter-currents; also that the foul air spread out in the space above the ceiling, and cooled so as to fall back and rest on the ceiling, may have as little as possible of its base unsupported and ready to fall back through the vents, should an interruption of their flow allow it.

4. Roofs or drainage-slopes may diminish in declivity the lower they descend, as rivers do; because the upper waters have only their unaided weight, while the lower are impelled also by those behind: so that, however small the whole descent, it may always be improved by taking steepness from the lower part, and giving it to the upper. And thus the ceiling surfaces must be steepest at places farthest from a vent, and their slope may diminish toward every outlet, where the foul air stratum has its motion aided by impulsion from that behind it.

And the differences will be these:—

1. Of course they do not need the same materials or strength.

2. All the vent-slopes require, for equal lengths, a far greater ascent than any drain-slopes require descent. For while the friction is alike on both, the moving powers are very unequal. Equal quantities (*i. e.* weights) of the two fluids are each impelled by the difference between their own weights and that of the air they displace; or rather, *both* these weights together, that of the displacing and the displaced fluid, are moved by their said difference. Now water being 800 times heavier than pure air, the *difference* between the weights of a descending mass of water and the mass of air it displaces, will be to their *sum*, as 799 to 801,—that is, 801 lbs. of matter are here moved by a force of 799 lbs. But supposing the difference of temperature between the pure and foul air to be 20° (which it will hardly equal in hot weather), their difference

of weight will be about $\frac{1}{24}$ of either, or $\frac{1}{48}$ of their sum;—so that, here, 48 lbs. of matter are moved by a force of 1 lb. Thus while the breath rises in hot weather (76°), with a buoyancy only equalling $\frac{1}{48}$ of its weight in vacuo, the water runs down with a force of $\frac{799}{801}$ of its weight in vacuo. Whence, whatever descent is needed in a yard of smooth paving that it may well and speedily clear itself of water, 48 times that rise *at least* will be needed by every yard of equally smooth ceiling, to conduct off the foul air to the nearest vent. So, remembering how far more essential *speed* of removal is in this case than the other, I think we may make it a rule for no ceiling-slope to average a lower gradient than 1 to 1, from its lowest point to the outlet.

3. Though the shape and size of drains be important throughout their length, those of the foul-air passages are quite unimportant after it once leaves the ceiling, because there is nothing here analogous to the viscidity and deposits of sewage.

4. Though drains must have a descent all the way to their outfall, the foul-air ducts need not rise all the way to the open air, as Tredgold recommended, (who, in his "Warming and Ventilating," edit. 1836, advocated these identical principles, though not to their full extent). They need not even rise at all, after leaving the ceiling; for the fluid to be got rid of being elastic, and quite filling them, the current entering them will always, whatever their shape, expel an equal current at the final outlet, provided it do not face the wind; which is

to be avoided by making them open at both ends through two opposite external walls, so that one outlet may always be to leeward, and effective. Further, there is even an advantage in the foul air cooling and sinking a little, after flowing out of the ceiling vents, as this ensures its not re-entering them.

5. Vents must be much nearer together than the sinks meant to drain water from a roof or terrace, because the water retains its motive power, its gravity, so long that there is no *haste* about getting it away (only provided it have not time to overflow its channels, as at the "Crystal Palace"): but the foul air loses all its upward tendency before many seconds; so that it must not be played with, nor have far to go, at least before getting through the ceiling,—after which it ought to be safely prevented from returning. Moreover, in domestic rooms, unless the vents be numerous, so that the slopes may be short, they could not have an ascent proportioned to their length without giving the whole ceiling a wasteful height. By having a vent, say, to every square foot, the base of the longest slope will not exceed 9 inches; so that the slope may be 1 to 1, and yet the extreme difference of level be included in the depth of ordinary joists.

We see, then, that for sanitary *innocence*—all apartments must be ceiled (unless the purpose be such as to admit openings in the roof, as in Moorish baths); that the ceiling must consist of one or more pyramidal (or still better, *domical*,) cavities,—(the

reason for a domical slope has been shewn above—"Resemblance 3"); and that in domestic rooms these must be so numerous as not generally to exceed a square foot in area each. Of course we may make them in plastered lath, like our present fever-holders, or in any other material; but I believe they will ultimately be made cheapest in *pottery*, and each in one piece. They may be of any quality, from brick to porcelain; remembering that a glaze, to diminish friction, though not imperative, is to have precedence of all ornament; *i. e.* not lawfully to be omitted where there is *any* ornament. To fit between the joists, they must be of a square-based dome shape, in section like a pointed arch; and their vent, if single, may rise as near to the flooring above, as half the width of its aperture; indeed *should* do so, that the outflowing current may be immediately spread laterally, and not return. Hence, where there is no floor above, it would be better (and where there *is* one, it would save a little height,) to have four vents, sloping outwards, from *close* to the internal apex; and they should be nostril-shaped, (fig. 21.)

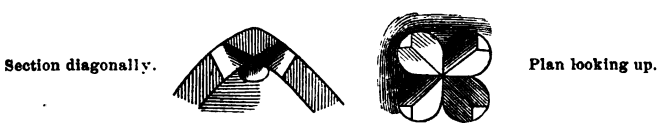


Fig. 21.

every care being requisite to conduct the light fluid, without the smallest obstruction or lodgment, from its first touching the ceiling anywhere,

till its safe passage through it. Any lodging-place for it, will retain, cool, and send down, like our present ceilings, a constant supply of the poison. Hence the joists, dividing one row of these pots from another, must have their under face bevelled off each way, like the cut-waters of a bridge; and similar cut-currents must be formed by the bars (of whatever material) laid across from joist to joist, to receive the edges of the pots (and which will also perform the function of our present strutting). A little mortar thrown into the trenches above these junctions, will make them tight against the downward return of cooled foul air.

The final outlets (for summer) must be between every two joists, in every wall, external or internal, that receives them; and their collected area must *at least* exceed twice that of all the ceiling vents, because one half must always be supposed stopped by the wind; and the larger they are the better, because the only available motive power to expel the air through them, is the current through the ceiling vents, produced by the heat generated in the body and communicated to the breath *for this purpose*. If we economize this heat *to save fuel* (as we do in all present buildings), of course we must use fire-heat (or steam-power derived from it) to *ventilate*, *i. e.* to botch up some substitute for the natural action we have prevented (and which I have shewn *no* artificial ventilation can replace); so that we pervert both sources of heat to unnatural and false

uses;—nature having designed the *breath*-heat to carry breath out of our way, and bring us fresh air in its place; and the *fire* to warm us, when necessary; which uses our ventilationists contrive to transpose. Moreover, as it is absurd to fancy the masses of mankind ever will, between this and doomsday, have *artificial* (*i. e. forced*) ventilation, the question for them lies simply between the natural ventilation unobstructed, or (as at present) *no* ventilation; but instead thereof, a saving of as much fuel as the paltry modicum of warmth retained with the foul air may serve instead of. It is simply whether, having obtained *nearly* all the heat we need in winter, by consumption of wood or coal, we will get the remainder also at the expense of wood and coal, or of human flesh and blood.

An innocently constructed place, then, will (*cæteris paribus*) require rather more fuel to warm it (with the same apparatus) than one with a chance or fancy ceiling does; and will need a fire on some days when we do not need it at present. This must not be confounded with the nuisance of cold draught descending through the ceiling vents, which is quite another thing, never necessary, but which will always be liable to happen with any *real* vents, (*i. e.*, with any whose action is not defeated by some of the many contrivances for quieting sanitary conscience by a sham ventilator,—a demonstrable hole to the open air, but through which nothing can pass). I say it may always happen with effective outlets, if either *they* be too large, or the inlets of

fresh air about the floor (which in private buildings will hardly ever need special provision) be smaller in collective area than the vents, so that their deficiency is made up by indraught through the latter. This latter cause, then, may be always provided against; and if, when the architect has done so, the evil should still occur (in summer, for I am not speaking yet of the sanitation of *warmed* rooms),—then the ceiling-vents (not any others) are over large, and must be *each* reduced. Thus a few experiments may be necessary at first to determine the right size of these. But when determined for one case, it will be calculable for all; because one definite *velocity* for the outflowing currents will always be the best, in every building alike; and knowing this velocity, we can, from the known hourly production of foul air (4 or 5 cubic feet per man or candle, and 12 or 15 per foot of lighting gas,) reckon the collective area for all the ceiling-vents, and hence the size for each. The final outlets may be as large as we please; and the fresh-air inlets never less than the above area, nor than half a square inch per head, rather more per candle, and about thrice as much per foot of gas, per hour,* that the required quan-

* If these minima be startlingly less than the artificial ventilationists require, it must be remembered that with proper ceilings we only require the change of as much air as is *actually used;* while they, to botch up matters with the flat ceilings, or whatever architects have left them, are obliged to allow for not only this amount, but an indefinite quantity besides, of *good air spoilt* by admixture with foul, and air used for what Dr. Arnott calls "*dilution of the foul air with fresh.*" He might, consistently with this, propose *dilution* of sewage to serve again as drink.

tities may be drawn in never faster than one mile per hour, an imperceptible draught; but it is best greatly to exceed these minima.

In public buildings, the ceiling pyramids or domelets will require neither the small size, large number, level arrangement, nor in short the *sameness* in any respect, of these domestic ones. Observe that the more people you have assembled, the *fewer* and *larger* may they be; because the abundance of respired air will give it volume and impetus enough to flow, without cooling, up a much longer slope than where it is in smaller quantity; thus bringing us to the somewhat paradoxical result, that the larger a place be, the fewer vents will it require,—the *fewer*, observe, not the *less* in area. In the Pantheon, *one* suffices, while in the small Alhambra baths there are several; and in the *still smaller* vestibule to them, having no bath, and no vapour to escape, there are many *more*, no less than sixty-five.*

We have then, in a public assembling-place, seven elements for variety in ceiling design. The compartments may vary in *form*, in *size*, in *level of base*, in *inclination* thereof, in *ornament of their surface*,

* The latter (which is figured in Weale's "Rudimentary Treatise on Warming and Ventilation" (Tomlinson's), and fully described in Murphy's great work, "Antiguedades Arabes de España,") is a fine instance, though without a roof above, of a ceiling completely fulfilling all the sanitary essentials, *as far as known to us at present*, and a striking proof of the scientific attainments of the mediœval Arabs. Nor do the ancient Romans appear to have been in this matter much behind them.

of their separating members or *ribs*, and of their separating *vertical surfaces*, if in different levels. I mean that, fulfilling all the above sanitary requirements, we may still make each cavity of *any* size (below a certain limit); with its base of *any* regular or pleasing figure; that base horizontal, or inclined at *any* angle, to suit the roof above, or the arched or trussed bearers; or at *any* difference of level from the bases of adjoining cavities; and if so, separated from them by vertical surfaces with *any* true decoration; or if not, by ribs or bearers of *any* moulded profile or other decoration not interfering with their action as cut-currents; and lastly, with *any* true surface decoration in the cavity itself—seven *anys*: whence it appears (to use Mr. Ruskin's mode of reckoning such things) that an infinitude of the seventh order will express the scope for variety that artists have in designing ceilings, without transgressing sanitary innocence,—without economizing thought at the cost of their brothers' blood;—and thus I see no more reason why (even when limited by this condition) any two ceilings in Europe should be alike, than the Turks appear to see for making theirs alike.

How the warming in winter may be prevented interfering with these ventilative arrangements, will be shewn in an Appendix.

But for what we actually see, it would seem needless to add that in no places really aërated and harmless can any lamps require special "ventilation" of their own. What does a lamp do with

air? Vitiate, rarefy, and send it away straight upward. What does a person do with it? The same. The place, then, that is unfit for one unprotected, is equally unfit for the other; and ventilators of lights, by their own act, convict their buildings of blood.*

Indeed, a room with proper ceiling and outlets (and sufficient inlets, which they *always* have,—the fault is not here,) could never retain any smoke, or any effluvium lighter than common air for a minute; while ours retain them for hours, or require violent air-*washing* or "*flushing*," unattainable in calm weather, to get rid of them. This whole system of "airing" by windows or other draughts, is a barbarous makeshift, betraying the original fallacy of the *designer's* work; as does also the calling in doctors, &c. to mend it for him (with steam-power, furnaces, Victoria Towers, &c.); and the necessity, acknowledged by all but the very poor, for *relays* of rooms; which necessity would wholly cease if the designer of buildings knew what it is his duty to learn and apply,—would have ceased as soon as pneumatic chemistry was discovered, two generations ago. Nor would *windows that open* be needed; as, in a room whose air

* When a light, however, is vertically under a vent, the latter should have a shield suspended half an inch or so below it; because (as Tredgold pointed out) the strong unbroken current straight into the aperture would hinder, or even prevent, the exit of the weaker streams flowing in laterally along the ceiling-surface. By means of the shield (which is an invention as old as Pliny) these indirect currents are allowed a fair chance.

remained always equally fresh, there could be no conceivable circumstances in which their opening would be other than prejudicial, letting in heat in summer and cold in winter. All these clumsy expedients, no better than those of the merest savage, have survived for seventy or eighty years the ignorance that justified them; and seem likely to survive, to the ever increasing waste of human labour, health, and life, till the public takes its architecture into its own hands; at least as far as it does other matters. (See Appendix.)

TECHNICAL TERMS IN PLASTERING.

Pricking up or Rendering is the first coat of coarse stuff, as lime and hair laid on the walls. If intended to be floated, it is crossed, as a key for the next course or coat; if it is only intended for setting or two-coat work, then it is not crossed, as it is not necessary, and would shew through the thin coat of lime and hair.

Render set is two-coat work on walls; viz., one coat of rough plastering performed with lime and hair, and one coat of fine stuff, which is called setting: this is performed by laying on a very thin coat of fine mortar, denominated finishing stuff, which must be well trowelled to prevent its cracking.

Render float and set is three-coat work: one coat of rough plastering crossed; another coat laid on ditto, and floated with a long rule to make it per-

fectly straight on the face; and one coat of fine stuff or setting on ditto, as "render set."

Lath and plaster is lathing on quarter partitions, &c., and one coat of plastering only laid on the laths, as pricking up or rendering is on the walls.

Lath and plaster set is two coats on the lathing, as "render set" is on the walls.

Lath, plaster, float and set, is three-coat work on the laths, as "floated render set" is on the walls.

Trowelled stucco. This work, either on walls or partitions, is performed as before described for setting; then a thin coat of stucco, which is prepared with a large portion of sand, and laid on similar to the fine coat called setting, but worked with water, and trowelled till it is perfectly hard and solid.

All rooms that have plaster cornices must either be floated or have a screed formed all round them, to obtain a straight face for running the cornice by.

Rough cast is pricked up and floated as if to be set or stuccoed, and then the rough cast (which is composed of half lime and half small stones) thrown with force into ditto; and consequently appears rough on the face when finished.

Depeter is pricked up and floated in a similar manner, and small stones forced on dry from a board, by which the face of wall is finished rough, and the same colour as the stones used.

Depretor is plastering done to represent tooled stone.

Pugging to floors is pricking up between the

joists of floors, either on laths or boards, to prevent the sound escaping from one room to another. This should be performed with coarse stuff and chopped hay, if on boards; but if on laths, with lime, sand, and hair; and not less than $1\frac{1}{2}$ in. thick in either case.

Ornaments are said to be worked by hand when they are so designed that they cannot be cast; which renders the work very expensive, as every part must be performed in the plaster as if modelled in clay.

ABBREVIATIONS.

R R	Rough render.	R C B	Rough cast on brick.
R S	Render set.	R C L	Rough cast on lath.
R F S	Render float and set.	If any of these are whitened, add W	
L O	Lath only.		
L P	Lath and plaster.	W N W	White to new work.
L P S	Lath and plaster set.	W S W	Wash stop and white.
L P F S	Lath, plaster, float and set.	L W 1^{ce}	Lime white once done.
S B	Stucco on brick.	L W 2^{ce}	Lime white twice done.
S L	Stucco on lath.	C C	Common colouring.

ROTATION.

In measuring plasterers' work, first take the ceiling; second, the sides; third, the cornices and enrichments.

MEASURING. (Plate 8.)

Plasterers' work is taken superficially, and valued by the square yard of 9 feet.

If cornices are round the room, take the ceiling only to half the projection of the cornice, or one projection in and one out; or measure the ceilings

clear of the cornices, and take the whole of their projection as lathing and pricking up.

If the cornices are bracketed, (as fig. 1.) measure the ceilings clear of the cornice.

The sides of the room should be taken from the ground, through the bed-mould, or half the height of the cornice.

If on brick, or bracketed, (as fig. 1.) take them only to the bottom of cornice.

In taking the length of cornices, measure the size of the room, taking one projection in and one out, and girt them from the mould or from the ceiling to the wall line.

Number all the angles in the room above four, as extra.*

In taking cornices where there are coves, take the coves as superf. of cove to cornices, and allow 1 inch extra on the girt of the cornice for the return of the mould on the cove.

All enrichments to be taken separately.

Friezes, under the cornice, must be taken as superf. of plain floated frieze. A floated ground must be taken under all enriched friezes.

If cornices are run to old ceilings, a screed must be allowed.

* The present practice, however, of making four additional mitres to carry the cornice round a projecting chimney, is as absurd a deformity as it is an extravagant waste. Even the architects of the last generation had the wit to keep their ceiling a simple rectangle, by arching in brick the recesses on each side of the chimney.

Enriched friezes, ceilings, or soffits must be measured first as plain work, and then the enrichments taken separately at per foot run, and a price fixed according to their description and value.

All circular mouldings and enrichments to be taken one face in and one out, fig. 3.

To explain the foregoing rules, see Section of a Cove Cornice, &c. &c., fig. 2.

Take first the ceiling through the reeds.

Second, length of cove above the cornice by 2 ft.

Third, length of moulded cornice by 1 ft. 2 in., being 1 in. extra for top on cove.

Fourth, do. of plain floated frieze by 6 in.

Fifth, do. of moulded architrave by 8 in.

Sixth, do. of moulded reeds by 9 in.

Reveals to windows taken at per foot run, price according to width.

ABSTRACT.

YARDS.													COLOURING.			SUPERF. FEET.			FEET RUN.	
RR	RS	RFS	LO	LP	LPS	LPFS	FSB	FSL	WSW	WNW	LW	Common.	Lemon.	Green.	Plain Frieze.	Plain Cornice	Stucco groins.	Quirks.	B & D Quirk.
												Grey.	Blue.	Red.				Circ. do.	Circ. do.
																		Numbers.	

As some of these articles will not be whitened, as for papering, &c., place them all in the Abstract as not whitened, and the whitening in a separate head, as "W N W"—White to new work.

ROTATION

To be attended to in bringing the quantities into Bill.

PLASTERER.

Yds.	ft.	in.				
			Rough render			
			Render set			
			Floated render set			
			Lath and plaster, one coat .			
			Lath and plaster set . . .			
			Floated lath and plaster set .			
			Stucco on brick			
			Stucco on lath			
			Pugging			
			White new work			
			Wash, stop, and white . . .			
			Lime white			
			Colouring, as the case may be .			
			Superf. of plain cornice, &c.			
			&c.			
			Then the			
			Run of cornices, girt, &c. . .			
			„ reveals			
			„ beads, &c.			
			„ Nos. of mitres, &c. .			

VALUATION OF PLASTERERS' WORK.

CALCULATION OF MATERIALS.

1 hundred of lime = 25 striked bushels (old measure).

	Materials.	Labour.
100 yards of render set require	1½ hd. of lime. 1 double load of sand. 4 bushels of hair.	Plasterer, labourer and boy, 3 days each.

	Materials.	Labour.
130 yards of lath, plaster, and set require	1 load of laths. 10,000 nails. 2½ hd. of lime 1½ dble. lds. of sand. 7 bushels of hair.	Plasterer, labourer and boy, six days each.

LATHING.

1 bundle of laths and 384 nails will cover 5 yards.

RENDER ONLY.

187½ yards require . . 1½ hd. of lime.
2 double loads of sand.
5 bushels of hair.

Floating requires more labour, but not more than half the quantity of stuff as rendering.

SETTING ONLY.

375 yards require . . . 1½ hd. of lime.
5 bushels of hair.

20 per cent. is always allowed on the prime cost of the materials.

Calculation of Labour.

The decimal is to be multiplied by the rate of wages for plasterer, labourer, and boy, per day.

	Days.
Rough render	.019
Floating do.	.021
Setting	.016
Lathing	.019
If circular work, add on the lathing and also on each coat of plastering	.008
If to groins, add as above	.010

SMITH AND FOUNDER.

REMARKS ON METAL-WORK.

THOUGH we may by no means bring ourselves to subscribe that most singular of Mr. Ruskin's dogmas, that *iron* constructions *cannot* be *architecture*,—though we ordinary mortals may not see, in the fact of animals having calcareous bones and shells, any reason why buildings should *not* have metal ones (by which marvellously conclusive analogy he thinks he *has proved* this point!); still I think we must see that the ordained and unalterable disproportion between the abundance of stone, brick-earth, and ore, on this planet, and between the labour necessary to convert each to use, must at all times and places render the former materials cheaper, strength for strength, than even the cheapest of metals, (besides being more durable); and must thus perpetually, as by a natural law, confine the latter to small accessories in building; and that, for it to play a large or quantitatively important part in construction, is unnatural, and can never happen but from an abnormal state of things. It happens at present among us, purely as *a substitute for science and con-*

trivance; a substitute permitted by an unnatural public ignorance and mystification on these matters; and necessitated by a preternatual greed, allowed to grow into money madness, outwitting itself, and duped on every side by the unnatural crafts it calls into existence and supports, as a putrid thing supports maggots.

The iron monsters of our present engineering indeed, the tubular bridges, the "crystal palaces," are, as Mr. Ruskin has said, (but only attempted to prove,) not architecture or art, and never can be so. But why? Because they are of iron, or glass? He might as well say, "Because they are neither Greek nor Gothic." The reason, I apprehend, has nothing to do with their material, except as that material and the unskilled labour are made substitutes for skill and thought; and made so to a monstrous and unprecedented degree; spent in *any* profusion to save the *smallest* art; the licence to do this having increased ever since the decline of mediœval art, till it has in these works freed itself, and spurned all bounds; so that we see the manual labour of thousands squandered to save the brainwork of one. This substitution, gradually made ever since the culmination of Gothic art, is traceable earlier and more constantly in England than anywhere else. It methodized and reduced to sameness the "Perpendicular" mouldings, panels, foliations; it introduced pseudo-architecture (if not earlier here than elsewhere, at least brought more precipitately here to the utter abandonment of reality); it kept behind

thinner and thinner masks, till an age came that would tolerate it naked; then threw them off, and behold two new arts, *Engineering*, and *Antiquarian Mimicry;* which in fact are both varieties of the same, the art of concealing the absence of art. Or rather, the latter is the art of concealing it, and the former that of palming it off by impudence and noise. Both are open abdications of the same human prerogative, both brutish; only that one takes the monkey or parrot, the other the swine, for its model. Now it is not, in this latter, the material, or the absence of ornament, that disgusts; but simply the absence of design,—the reversal of that quality most admirable in the works of nature, viz. foresight and provision for all contingencies, from the first. Architecture, in its progressive times, aimed at the utmost approach to this,—at an excellence the same in kind with that of nature's works, though of course always imperfect in degree; and so did the earliest works called engineering (Smeaton's, for instance), which are architecture,—far more truly so than Chambers's, or any then or now called so. But *now* engineering works appear to renounce this aim, to be planned just as they proceed, or as difficulties occur to the mind; the *design* usually impracticable or useless, and every failure cobbled up just as it occurs (either actually, or to the designer's mind, or to *other people's*); whereas, in a work of art, all the members have so mutually influenced each other's design, that often we cannot discover by inspection

any one thing to have been certainly planned before or after another; and if we can, we call this an "*afterthought*" and a blemish. But the principle of engineering is to be *all* afterthoughts, from the second thing made or planned, to the last. And this, its exact contrariety to *design* or *art*, as well as its expression of unparalleled, unbounded self-sparing,—unchecked power and will to waste *any* amount of others' labour for the *least* of the designer's own, is what must render our great iron structures ever painful and humbling to behold, like the pyramids of enslaved Ham,—ghastly blots permitted on our planet's face, as monumental warnings to what self-interest in its unalloyed simplicity may bring us.

Iron could not, then, be used in this manner, but for an unnatural licence to designers, arising from an unnatural ignorance of their work by employers, goaded on in uncontrollable periodic fits of frantic cupidity. All this is local and temporary; and hence we may assume that iron can hardly, in rational construction, enter anywhere *much* more abundantly than it has done in the mediœval architecture of countries where it most abounds. Now in mediœval architecture, as Mr. Petit observes, "iron only makes its appearance in the form of bands or ties,"—that is, as a bearer of direct tension alone. But then the iron used in past architecture has been all *wrought* iron; and the very different qualities of the almost new material, *cast* iron, which are too valuable not to be made use of,

(certainly *would* have been made use of in the middle ages, if sufficiently common,) must require a totally different application. Wrought iron is stronger to resist tension than compression; cast iron just the reverse, being in this respect like stone or brick, while, though not so brittle, the great irregularity and uncertainty of this property in it, renders it even *less* fit than these to be trusted with any but a directly compressing strain. Hence the late Mr. Bartholomew observed (Pract. Arch. § 323), "the only legitimate and scientific use of cast iron in buildings is the subjection of it to *compression:* nearly all the instances of its use in modern architecture, where it is subjected to the cross-strain of its own gravity, and to that of a heavy additional load, savour strongly of a decline of art and skill." Since this was written, however, that surrender of scientific principle has become almost universal; and on failures of iron beams, the coroners have actually been told, in extenuation, that architects "were left no other resource." (It must sound odd, that, with ever increasing "resources" for every other art, the architect's should be dwindled so low.) Now I have yet to see, or hear of, or conceive, any possible case occurring in modern building requirements, from a shed to a palace, from a city warehouse to a farm, from crossing a ditch to bridging an estuary, that can require, or anyhow justify, the use of cast iron in pieces exceeding a foot in any dimension.

Except in such small pieces as drain-gratings and perforated floor-plates, neither cast nor wrought

iron can rationally be applied as a horizontal bearer, supported at the ends, and liable to a load between them. One material is too flexible, and the other too uncertain in its transverse strength, and both too expensive to justify so unscientific and wasteful an use. We need not therefore add any information about *lintels*, *beams*, or *girders*, cast or wrought, solid or tubular, as they are wholly indefensible on economic or any other grounds. Some experiments and a few equations have enabled engineers to say they make them of the "most economic form," *i. e.* the most economic section for a mass *whose axis is straight*, and its *section equal and similar throughout*. This is much as if we were to boast of writing the best treatise on a given subject possible, with ten words to every sentence and without using the letter A. In the present state of constructive knowledge among the general public, this bit of science answers its end; but the economy, I confess, I cannot see.

Assuming, however, as we must, that the main (if not only) object aimed at, in the structural use of iron, must be *incombustibility*, or total independence of wood-work in a building or certain parts of it, of course it behoves any one attacking these expedients to shew an incombustible substitute for them. This, I think, I have done in the tied brick arch (*fig.* 9, page 81), which is applicable to all the cases where iron beams have been used; contains, for the same strength, many times less iron; and has only the two small skew-backs that require a special casting; the bricks and rolled tie being

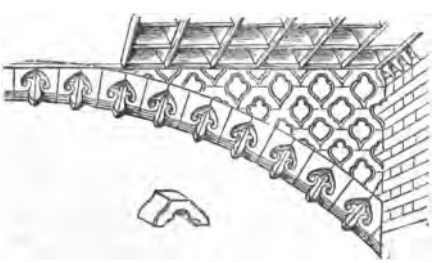
alike in all arches, and therefore admitting of wholesale manufacture. A tie which thus passes through the arch-bricks themselves, besides being protected from the air, has another advantage over straight chord-like ties. The latter do not, in an arch of more than 120° extent, truly meet all its lateral pressure, unless one of them were applied to connect *every pair* of opposite voussoirs below that pair which are 120° apart; for in arches extending below this, the side thrust is no longer confined to the springing, or any other point, but acts against the whole spandril, from the springing up to 60° from the vertex. Now the curved tie meets all such cases; for it acts by keeping together the lower corners of every two adjacent arch-bricks; and it is plain, that without a separation of two such corners somewhere, no arch can possibly spread. But an arch that cannot spread, may still push apart its abutments, if its end pieces rest on sloping beds, as in a common window-head. It cannot, however, if the last piece thus connected, at each foot, rest on a horizontal bed. Now this last piece is the skew-back, which will be necessary for this reason; at least wherever the arch does not extend to nearly a complete semicircle.

The curved tie indeed, having its ends pressed apart by the general thrust of the arch, tends to straighten itself, and thereby to *draw in* the arch-bricks radially, as with an addition to their weight, and (as it cannot do this, from their wedge shape) to tear out from them, or *cut its way through* their soffite or under side. It is to reduce this action

as much as possible that the tie should never be a straight one *bent*, but always *made* curved; and, to spread the same pressure over as much of the brick as possible, I have shewn the tie spread into a semi-tubular section, with its convex side downward, and lining as it were the cavity in the brick.

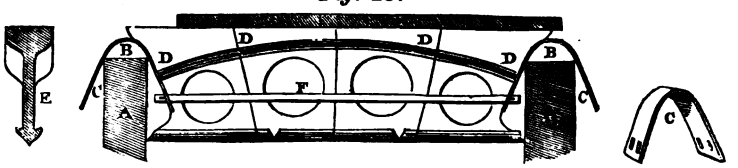
To support a fire-proof ceiling and floor, the primary bearers may be arches of this kind, with a radius of 12 or 12½ feet; for which I have shewn in fig. 10 (p. 87), there would be room in the lowest-proportioned rooms and passages now admitted, of every width up to 24 or 25 feet. These bearers should be nearer than girders are now placed, but more distant than joists. When we begin to find out that the Window Tax is gone, and that we may rationalize the fenestration, as above proposed (Brickwork, p. 42), intervals of 3 or 3½ feet will enable a bearer to spring from each pier, and the windows may extend as high as we like, between them. On the haunches of each bearer we must then build up to the level of its crown, in either 4½-inch ordinary brickwork (to be plastered on each face), or, what is far better, in some brick made for the purpose, leaving ornamental perforations for lightness, and requiring little cutting to fit the back of the arch.

Fig. 22.



These, as well as the arch-bricks, may of course have a surface of finer clay, and any decoration adapted to pottery. We next want an incombustible substitute for short joists, of 3 or 3½ feet, to span from bearer to bearer. These will require two or three more forms of brick, which the following figure will explain.

Fig. 23.



AA, Sections of the bearing-arches, or the filling over their haunches.
BB, A brick segment of a cylinder, of 2½ inches radius, 4½ chord, and 4 or 5 in length, to be placed on each bearer wherever it receives a joist.
CC, A bent plate of rolled iron, 18 inches by 4 or 5, to ride as a saddle on each of the cylindric segments BB.
DD, The substitute for a joist, composed of good brick or tile, in either 4 or 6 pieces, according to its length, but 4 (of only *two* forms) will generally suffice. E shews its section in the middle, the upper flange growing deeper to each end, and being the whole effective part of the arch. The perforated veil hanging from it, need not be thicker than a plain tile, and only serves to suspend the lower flange, which is to receive (and divide as a cut-current) the domical pots that form the sanitary ceiling, as explained above. (Ceilings, p.197—207)
FF, The ties for confining this joist-arch, to be of common hoop iron, and double, one on each side the thin parts of the joist-bricks; their ends passing through slits in the plates CC, and keyed outside.

The clear interval of these joist-arches must be an aliquot part—either third, fourth, or fifth—of that of the primary bearing-arches; that the space between each may be ceiled with three, four, or five square ceiling-pots, such as we have shewn are necessary to sanitation. The meeting edges of these should meet on a bar of their own material, resting in notches left in the lower flange of the joist-bricks, and forming, like that member, a cut-current for ascending air. Thus the whole visible ceiling will be of one material, and may have any colouring and a glazed surface. "It is no more necessary," says Dr.

Robison, "to consider the members of a roof as a thing to be concealed like a garret, than the members of a ceiling, which form the most beautiful part of the Greek architecture." He might have said, the most beautiful parts of the Gothic too, and which might be—*ought to be* (if it be right for ornament to increase upwards, and be greater within than without)—the most beautiful part in *every* kind of architecture, even our common domestic.

For a floor, we may span the intervals of these joist-arches by either paving tiles, long bricks made for the purpose, or split slates, such as we use for roofing, covered with a layer of plaster, cement, or asphalte. But the most luxurious flooring without wood, might probably be large sawn slates. Slate is peculiarly pointed out for a flooring material by its great transverse strength, far exceeding other non-metallic bodies.

The great error of ignorant fire-proof constructors, is to replace the *wood* of ordinary buildings by *iron*, which we have shewn is a barbarous extravagance. It is *brick* or *stone* that must stand in the usual place of *wood*, and the only call for iron is (as in mediæval architecture) for a tensile material, and in very small quantities. Indeed, there would be no call for it, were we less limited as to economy of space and height. The Gothic church masonry is fire-proof without using iron at all; so that it is not for *incombustibility* that iron is required, but purely for *economy of space* (and particularly of height) in incombustible building.

Having shewn how to dispense with all wood in

walls, floors, and ceilings, it only remains to do the same for roofs. The iron roof-trusses introduced by the engineers, being merely copies of wooden ones, partake of the above fallacy, and are extravagant. There is no necessity for any of the *cast* iron they contain, (except perhaps in shoes, nuts, and other small connecting pieces,) as the lengthy compressile pieces would be far more economically made in burnt clay, and better too, because, being larger for the same strength, they would be less liable to bend or crack. Indeed, the extreme resistance of cast iron to compression renders it quite improper that longitudinally compressed columns of it (as struts, rafters, pillars,) should ever be *solid*, since they must then, unless much larger than is required to resist crushing, be very slender, and liable to bend with any irregularities in the pressures on their ends; which is best obviated by making them always *tubular*, and with a diameter in the middle bearing some constant relation to their length; though this diameter may diminish each way, to as little as we please at the ends. But after all, the use of this or any brittle material in *lengthy* pieces, is a barbarism; and besides, the best brick must always and everywhere be, as a compressile material, much cheaper, strength for strength, than cast iron.

Now the rafters of a truss are compressile members; and we said (Carpentry, p. 102), that if made of inorganic matter, their true form for equilibration would be curved outward; and we only make them straight to suit the fibrous nature of wood. In using brick, this reason no longer applies; yet if

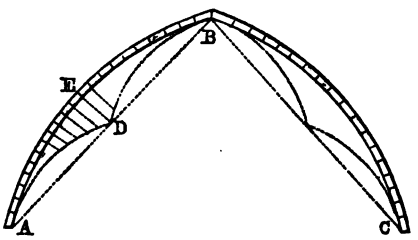
we made them curved, like the sides of an arch, and very slender, as a particular curve would suit only a particular amount and distribution of load, the slightest change in *that*, the mere putting on or taking off some of the covering, would derange the equilibrium. Of course, the internal strutting and stiffening obviate all this, and ensure safety with a rafter of *any* curvature, or *none*, or even curved inward; because it is no longer necessary for the line of thrust (of the two rafters and their load, regarded as an arch,) to fall within their own substance, but only within the depth of the truss-work. Still I would here point out another way of effecting the same end more simply and elegantly, which was invented by either the Arabs or monks about 700 years ago, and would apply with great advantage to some mis-solved problems of importance in our present engineering.

Let A B C, fig. 24, be a pointed arch, liable to a variable distribution of load; and let this curvature in the sides be *not too small* for the most equable distribution of load that can happen; *i. e.*, the greatest load on the haunches, and least on the vertex, that can occur, will not cause the sides to flatten and vertex to rise.

Any other distribution, then,—*i. e.*, any greater relative concentration on the vertex,—will cause that to sink, and the haunches to bulge; unless we had a contrary change in the arch—*i. e.*, unless its curves were made flatter—so as to include the now less curved line of equilibration. And the more the load be collected on the top, the flatter must the

curves be; till, when it is *all* collected there, they require to be straight, like the rafters of a wooden truss. Now place within the curve A B, two

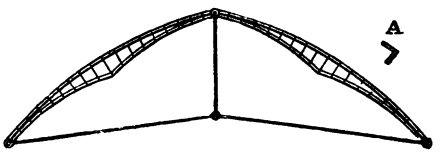
Fig. 24.



curves exactly similar to it, but on half its scale, so that they coincide with it at the ends, and meet on the middle of its chord line at D; and suppose its pieces or voussoirs to extend down to this double curve. Can any change of distribution in the load,—any extra pressure you can apply and concentrate on B,—*now* cause the haunches to bulge out? It cannot; nor can the arch fail in any way, but by the direct crushing of the materials; simply because, *whatever* form the line of equilibration may take, between the straight line A B and the greatest curvature A E B, it will always pass between E and D; so that this joint E D (otherwise the one most liable to open) cannot open. And it is easily seen, that, by the small curves, this advantage has been got with the *least possible* material. This is that beautiful invention, the *cusp* or *trefoiled arch* of Arab and Gothic architecture; and we cannot wonder that it should have influenced for centuries the whole taste of decoration, even after its structural use and meaning had been forgotten, or in countries where (as in England) they never

seem to have been known. For the disinterment of this fine invention, our engineers are indebted to Mr. Ruskin; though he has mistaken its mechanical theory, thinking the cusp acted as a weight hung to the arch to supply a want of it above; whereas it acts quite independently of its weight, and simply by giving the long joint E D, in whose length its whole virtue resides.

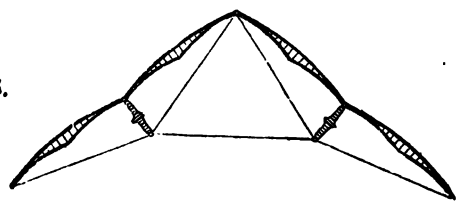
Fig. 25.



For all bridges that have the roadway suspended from the arch (as is now so common on railways), this pointed trefoil arch is the only true form of bearer; and there is no limit to the scale, or to the number and smallness of the pieces with which it may be built. To apply it as a roof-bearer, we should require a series of large thin bricks or tiles, of as many forms as would make one quarter (from the springing to the cusp) of the largest arch we may have occasion for; and a portion of this series would make a quarter of any smaller arch, the cusp still exactly touching the chord line. These bricks, or rather tiles, may be almost as thin as we like, provided they have a flange or rim all round them, presenting to each other beds of 3 or 4 inches wide; and the flange forming the outer curve should be much the strongest. All rafters or semi-arches, whatever their inclination or their length (up to that formed by using the whole series), might have the same radii, and be built with the same set of

bricks; and the brick No. 1, which begins and ends each, should have its end hollowed, to abut on a circular eye of cast iron, that would form the foot and apex of every arch, and receive the three wrought-iron ties that would be the only trussing needed. (Fig. 25.) For a roof too wide to be spanned by a pair of the longest of these rafter-arches, I see no objection to dividing each slope into two curves, as in fig. 26, and supporting their junction by a strut, which (like all other struts truly applied) may be built up like a column, of as many pieces as you like, and therefore of short brick cylinders, or trochoids. The first and last should be narrowed, and end in hollows, to abut on the round eyes of cast iron above mentioned.

Fig. 26.



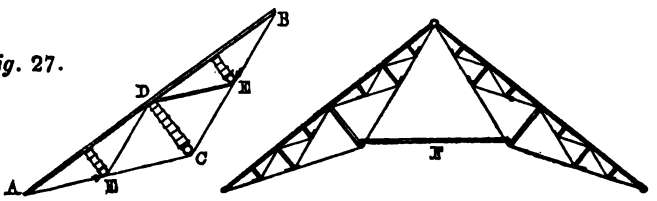
The best secondary bearers to lie on the backs of these trusses, and take the covering, would be of angle iron, in the position of A, fig. 25.

But I do not see how this cusp principle could be applied to any hip or valley roof; and as there are advantages in a straight rafter for some kinds of covering, let us see how the common truss principle could be carried out in these incombustible materials.

Suppose A B, fig. 27, a rafter of any metal, in section like an inverted trough. Supported at its ends only, it would bend most in the middle. Now

let the ends be connected by a tie longer than itself, as A C B, say of flat hoop iron; and pack in, between its centre C and the rafter at D, as many brick trochoids (or *strut-bricks*) as you can. These

Fig. 27.

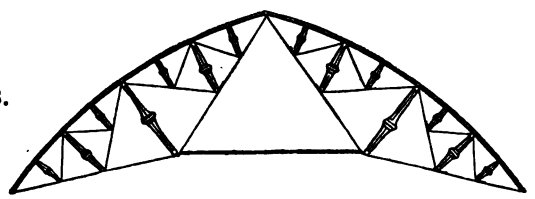


will form a column or strut to the rafter's middle, which will now no longer bend; but the points midway between this and the ends will bend most. Let another tie then pass between the rafter and strut at D, and be attached to the first tie at E E, and half the number of bricks used in the strut C D will form a strut from each point E to the points requiring support. And so you may go on bisecting *ad libitum*. We have thus a compact unyielding combination, that may be of any length we please, and will serve either as a common rafter, a hip, valley, or jack-rafter. Now to make a truss, we have only to connect two such trussed rafters by the single tie F, whose length will regulate the pitch of the roof; or, when it is of a very high pitch, F may be reduced to a mere bolt, keeping the nearer sides of the two triangles in contact. Either species of truss is unlimited as to scale, and the strength of the principal rafters need not increase with their length, nor bear any relation thereto, but solely to the weight of covering they

bear, per foot. The strut-bricks ought, for good work, to enlarge from the ends to the centre of the strut, and may have very ornamental profiles; and the terminal ones should, in this system, have somewhat the form of half-pulleys, to distend the ties that bend on them, without a cutting action.

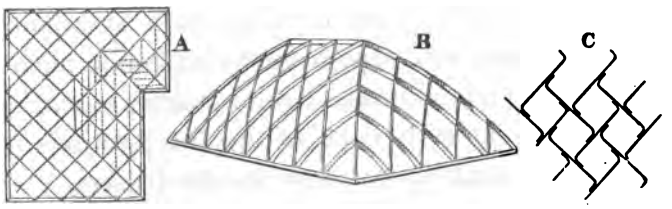
The method applies equally to curved rafters, provided all their struts be made in the directions of radii.

Fig. 28.



Yet another easy mode of roof-framing, on a small scale, occurs to me, in wrought iron alone, and without internal trussing. It consists in omitting all gables, making all the surfaces convex, and using, instead of rafters, curved ribs running *only* in the directions of hips and valleys; as on plan A and view B, fig. 29. These may be rolled to one constant curvature, or cut out of sheet metal, their broad faces being flat and vertical, and their edges curved. The pieces need not exceed in length a few inches more than two sides of the quadrangular spaces; and the way of bending their ends to rivet each to the *centre* of another piece, will be understood from C, an enlarged bit of the plan A. They must be similarly bent at the bottom, and riveted to the upright part of a wall-plate of angle iron; and the hips and valley ribs should be a double or

Fig. 29.



treble layer. The best horizontal secondary bearers will, as in other cases, be angle iron, its lower plane notched half through, and fitting in notches of similar depth, prepared in the above ribs.

This simple framing bears somewhat the relation to other iron roofing that Delorme's carpentry does to the common kind; but it could not so well be applied on a large scale, unless we added some sort of trussing to each arch or pair of ribs: so that every line in the plan A should represent a trussing plane, and every crossing an intersection of two such planes in a vertical line. On this account, the following kind of truss, fig. 30, would be appli-

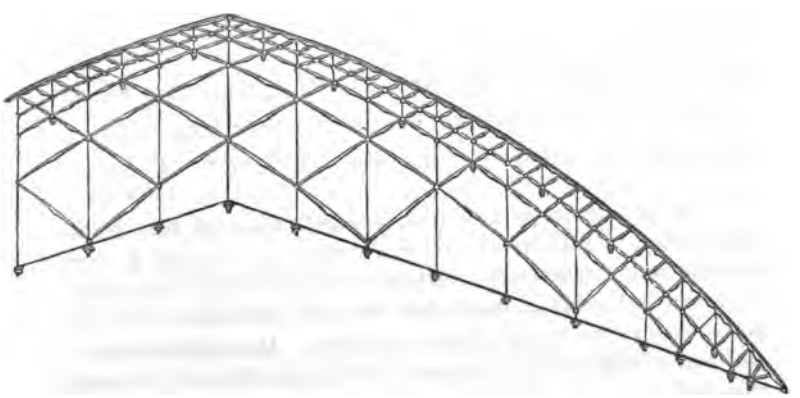
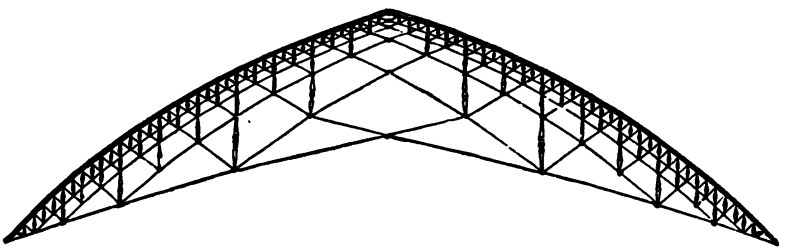


Fig. 30.

cable; the curves all representing compressile parts, archlike, and with a cusp between each two points of support; and the straight lines all being tensile, so that their verticality and equidistance would bring one to coincide with each of the intersections (on plan A), and make it common to two trusses.

Or the nature of all the parts (except the enclosing lines of the figure) might be transposed; the inclined lines being made straight and tensile, and the vertical ones compressile built columns.

Fig. 31.



And in either case the partial use of *zinc*, as a compressile material, might be made to produce such a relation between the expansions, by heat, of the vertical and inclined parts, as would make the expansion *horizontally* become null, and the whole rise and fall by expansion and contraction, without affecting the interval between the feet.* I see no

* The expansions of cast iron, wrought iron, and zinc, for the same change of temperature, are as the fractions $\frac{1}{9}$, $\frac{1}{7}$ and $\frac{1}{5}$, (proportions easily remembered); and they will probably yet be employed to correct each other in many more ways, and with many more purposes, than in the compensation pendulum. If a square frame of cast iron be stiffened by a diagonal having four-fifths of its length zinc, and the rest cast iron, the *other* diagonal of the square will be invariable in length.

limit to the scale attainable in either of these roofing systems; and their intricate regularity, perspective play, and grove-like repetition of vertical lines, would, I conceive, give them no small beauty and magnificence, if the nuts, eyes, &c. were only designed with a moderate grace and finish, somewhat as in the late London Bridge Station (only that they were over-done and over-classical). With the covering wholly or partly of glass tiles, they would well suit such purposes as a winter garden, or the roofing without a pillar the quadrangle of the British Museum (though we might spare *that* a few pillars out of those employed outside in casting shadows).

With regard to the metal plates used for clothing framed structures, they are of the same nature as tiling or other roof-covering, and of course require similar treatment. The engineers, after using them for some years, stumbled upon a "discovery" of the advantage of corrugating, instead of leaving them flat,—one of the many discoveries that any mediœval designer would have thought it his duty to make in the first metal building he had occasion to plan. Perhaps, in another generation or so, we may cease to see plates joined edge to edge, and buckling like sheets of paper; the advantage of fish scales over reptile scales, and other similar "discoveries," may gradually turn up and be patented: but before their engineerships can approach to an iron *architecture*, they must learn that such things as these are, in a time of real architecture, not accounted matters of

"discovery" at all, but duties of *design*—things to be evolved by thought, not accident. Accident may furnish progress enough for their purpose, but is far too slow a mode of progress to lead to decent architecture. There would not have been time, while the world lasts, to evolve a single style by this kind of progress, though it had begun in Tubal Cain's time, and occupied none in self-gratulation and trumpet-blowing, which real progress, we may rest assured, has no need of, and no time for.

What we proved of tiles and slates, that all their lappings must be diagonal, and therefore their general shape a lozenge (with the longest diagonal upright), applies equally to these covering-plates. But in the hands of men whose natural sense of beauty was not quite perverted, these rhombi would modify themselves into some leaf or scale-like abstraction of natural form; and their corrugations, if any, be stamped accordingly; and not in endless series of equal parallel furrows, inflicting, when strongly marked by sun and shade, actual physical injury on the eyes.

The raw edges of apertures would become rolls, ending downward in flower or bud-like terminations. Most ornament would be formed, as in old goldsmiths' work, by bending and wreathing leaf-like forms of the sheet metal. Every detail would have, as in Gothic architecture, its own protecting hood or capping, with the dripping edges serrated to collect the water to points. Everything would be evidently pendent, and shew itself without affectation

to be a dress or clothing to the skeleton which, though unseen, would be unmistakeably recognised as present.

There seems a difficulty about the colouring proper to the protective coatings of metal construction; a general feeling that the present opaque coats of common paint are not right, and a desire to distinguish metal from woodwork by a different class of colours, more characteristic of itself. Perhaps they should have rather the nature of varnish or lacquer, than paint—a certain transparency, that may allow the metallic lustre partially to shine through; or else the delicate colourings produced on gun-barrels, steel-pens, watch-springs, &c., seem very characteristic. In any case, framing should be distinguished in colour from clothing, the tensile part of framing from the compressile parts, and the ganglions or attachments from all the rest, so as to use commonly four colours, so gradated that the brightest and most positive may be on the parts most importantly placed, and smallest in proportion to their duty; the deepest and most neutral retiring to what is at once most abundant in quantity and least trusted to, or bearing only itself. Thus for mere clothing, space-filling, or even compressile members, our ordinary dull paints, or the electro-coating of peroxide of lead, might be proper; while the eye should be strongly drawn to those slender and small parts where the properties of the material are most called into play: and I think those parts which could not safely be replaced by anything

but metal, should have a metallic surface, or at least as metallic in appearance as oxidized zinc or the lacquers above-mentioned. Gilding, nickel-plating, or other untarnishing metal coats, might be reserved to the intensely loaded junctions of truss-work, or extended to the tensile nerves also. The simple rule is, to take care we shall see what it is most important to see in the construction, by making up for its smallness with proportionally greater brilliancy of colour or burnishing.

MEASUREMENT OF IRON-WORK.

Cast iron in girders, story-posts, columns, &c., is charged by the ton or the cwt.

Moulds are generally charged extra, if out of the common run.

Articles in common demand, as cast-iron water-pipes, gutters, &c., are sold by the yard, according to diameter.

Cast iron in railings, gratings, casements, brackets, &c., is charged by the pound, according to the nature of the work.

Wrought iron in chimney-bars, railings, hand-rails, shoes to piles, &c., is charged by the pound.

IRONMONGERY.

Nails are sold by weight, and charged by the hundred. Screws at per dozen. Iron bolts and

screws at so much each. Brass flush bolts at per inch. Pulleys each, according to diameter. Hinges and screws at per pair. Locks at per piece.

Twenty per cent. profit is allowed on the prime cost of all ironmongery.

PLUMBER, PAINTER, GLAZIER,

AND

PAPER-HANGER.

PLUMBER.

I AM aware of no attempt, in the present day, to humanize the design of lead-work, though it is generally one of the most conspicuous and ugly of external features, and though the lower edges of lead flashings, hips, and especially ridge coverings, ought not, on the utilitarian ground of best ridding themselves of water, to be straight, but serrated; and of course, among any who had not lost the natural love of graceful forms, this serrature would assume a leaf-like character, all the more general and more varied than the decoration of other metals and fictile materials, because the ease of cutting lead would render mechanical multiplication of patterns needless.

Wren, in endeavouring to save his cathedral from the infliction of the present barbarous roof balustrade, remarked that "ladies liked nothing without

an edging,"—that is, I conceive, a token of preparation for the finish, to shew it is a finish by *design*, and not by accident or afterthought. This taste for "an edging" is at any rate too general among those whose perception of the fit and beautiful is least blunted, for us to neglect it. Yet I must confess that all extraneous and *added* fringes and borderings, not springing from any utilitarian feature (the fringings, for instance, now spreading along ridges of tiled roofs), always remind me unpleasantly of millinery or toys; and perhaps what Ruskin says of crockets and finials, that they require the spectator to be brought into the right mood for enjoying them, and therefore are out of place in external or general architecture, applies equally to all *mere ornaments*, or things *made* for ornament alone. But this will not apply to hip and ridge leads, and other necessary lead work, which might, I think, by such treatment as is here proposed, be made as graceful and integral a *part* of the architecture, as they are now an ugly and apparently extraneous blemish.

As for water-pipes, they would, in noble buildings, be neither concealed, nor tacked on as afterthoughts, nor allowed to cut a wall by an apparent chink from top to bottom. It is a right feeling that has sometimes confined them to nooks or reentering angles; but I am inclined to think specially designed nooks upon the *salient* angles would be a still more proper place.

Plumbers' work is valued according to the price

of lead, at per cwt., to which must be added the labour; for which, however, we have not sufficient data on which to base a set of constants for this description of work. Lead-headed nails, wall-hooks, and holdfasts are charged per piece; clout nails, by the hundred.

Joints are charged separately.

Water pipes, funnel pipes, and socket pipes are charged at per foot, according to diameter.

Washers and plugs, air-traps, brass grates, spindle valves, bosses, ball and other cocks, at so much each.

Common lift, hydraulic, or force pumps, at so much each, according to diameter.

Water-closets, at so much each, according to the description of apparatus.

PAINTER.

ABBREVIATIONS.

1 O 2 O 3 O } 4 O 5 O 6 O }	Number of times in oil common colour.
F	Flatted, as 3 O F three times in oil and flatted.
D W	Dead white.
F G	French grey, or the particular colour may be written.
C C F	Clear colour and finish.
G W	Grained wainscot.
G M	Grained mahogany.

ROTATION.

In measuring painters' work, first take the windows; second, the skirting, dado, or wainscoting; third, the chimney-pieces, if painted; and last, the doors.

MEASURING.

In measuring painters' work, all work not cut in on both edges, must be taken, including edges and projections, at per yard square of 9 feet.

Work cut in on both edges, as skirtings, cornices, shelves, &c., are measured at per foot run.

Ornamental work first taken as common, and then superf. of labour to ornaments at per foot superf. or run.

Sash frames, window lights, casements, bars, dormers, frontispieces, chimney-pieces, &c., numbered and valued at each. Sash squares at per doz.

Iron or wood railings, balusters to stairs, &c., are measured on both sides as solid work, to allow for the extra trouble of painting round the bars, rails, &c., at per yard.

If ornamented, add extra one face in the width of such ornamental parts.

If ornamented turned balusters, also add one extra face as far as the turned work goes.

Handrails, &c., grained mahogany, first measure them in with the balusters, and then per foot run for graining.

Soffits to windows per foot run.

Letters or figures numbered and valued at per inch in height.

Windows and doors are measured thus:—(See Plate 8.)

WINDOWS (fig. 4.)

ft.	in.	ft.	in.	
11	0			Window front.
5	5			
				Shutters: 7 6 / 0 4 edges. = 7 10 ; 4 6 / 1 6 boxings and edges. = 6 0
7	10			
6	0			
				Linings: 7 6 / 7 6 / 0 9 / 4 6 = 20 3 (If the backs are cut away the linings must be measured to the floor thus:) ; 10 6 / 10 6 linings, 4 6 soffit, 0 9 elbows = 26 3 ; viz. 26 3 / 1 2
20	3			
1	2			
				Beads varnished, supposing them to be mahogany or wainscot sashes and beads: 7 6 / 3 9 = 11 3 ; 11 3 = 22 6
22	6			
				12 squares varnished.
				1 locking bar.
				Some only allow the shutters to be taken thus: . . . 1 6 boxings. / 0 6 edges. = 2 0 ; 3 9 shutters. = 5 9 instead of 6 feet.
				The outside of window would be taken as . . . . . N 1 frames. / 1 dozen of squares. / 1 sill, if the stone sill is painted.

DOORS. (Fig. 5.)

2) 7	0		Door fronts for both sides . 4 0 projection of architraves. / 0 4 = 4 4
4	4		
			Linings: 6 6 / 6 6 / 3 0 = 16 0 ; 0 6 edges of door and / 0 2 rebates. = 0 8
16	0		
0	8		

ABSTRACT.

Once in Oil.				Twice in Oil.				Three Times in Oil.				Four Times in Oil.				Five Times in Oil.			
Com.		Runs.	Nos.	Com.		Runs.	Nos.	Com.		Runs.	Nos.	Com.		Runs.	Nos.	Com.		Runs.	Nos.
And Flat.				And Flat.				And Flat.				And Flat.				And Flat.			

By this method every description of work stands in rotation in the Abstract as it should be drawn into Bill, and will likewise be found with much more facility on the Abstract.

ROTATION

To be attended to in bringing the quantities into Bill.

PAINTER.

Yds.	ft.	in.	
			Once in oil . . . . .
			Run of Skirting, &c. . . .
			No. sashes. Doz. squares .
			Twice in oil . . . . .
			Runs . . . . .
			Numbers . . . . .
			Three times in oil . . . .
			Runs . . . . .
			Numbers . . . . .
			Three times in oil and flat dead white . . . . .
			Runs . . . . .
			Numbers . . . . .
			If carved work, or any other per foot superf., it must be put under the yards of painting so many times done.
			Likewise party or other coloured work must be placed under the head of work according to the number of coats.

VALUATION OF PAINTERS' WORK.

Calculation of Materials.

45 yards of work, 1st coat, including knotting, stopping, and every preparation requisite for the second coat, will require .	5 lbs. of white lead. 5 lbs. of putty, litharge, &c. 1 quart of oil.
Second and following coats	5 lbs. of white lead. 1 quart of oil.

20 per cent. profit is always allowed on the prime cost of the materials.

CALCULATION OF LABOUR.

The decimal to be multiplied by the rate of wages for a painter per day:—

First coat, including stopping, &c. .	.027
Second and following coats . .	.019

The above data will suffice for the valuation of common work, for which alone it is possible to lay down any rules, as the value of decorative work, as graining, imitations, &c., depends upon the ability of the artist, and the manner in which the work is executed.

GLAZIERS' WORK.

In measuring glaziers' work, the dimensions must be taken between the rebates, and all irregular panes the extreme size each way.

The price per foot must be calculated from the prime cost per crate, allowing for carriage and 20 per cent. profit. The larger the panes are, the more difficulty, risk, and waste; consequently the price should increase in the following proportions:—

	ft.	in.		ft.	in.		
Panes whose superficial contents are . . . . . under				2	0	at per foot.	
Do. do. do.	from 2	0	to	2	6	add 2*d.*	Above the squares whose contents are under 2 feet.
Do. do. do.	do. 2	6	to	3	0	add 4*d.*	
Do. do. do.	do. 3	0	to	3	6	add 6*d.*	

A CRATE OF CROWN GLASS

Contains 12 tables of the best, at per crate
„ 15 „ seconds „
„ 18 „ thirds „
„ 18 „ fourths „

Each table is from 4 ft. to 4 ft. 6 in. diameter: some tables may be cut to within 2 in. of the centre, others not nearer than 4 inches.

	ft.	in.
Supposing a crate to be 4 ft. 6 in. diameter, and that it may be cut to 2 in. from the centre, the quantity of glass that may be cut from it, including the triangular pieces, will be	14	2
If only 4 ft. diameter, and cannot be cut nearer than 4 in. of the centre	10	10
	25	0
And deducting the triangular pieces, which are of very little value	2	6
We have as the available contents of the two tables .	22	6
The average contents per table	11	3

Taking the sizes of squares that will cut to the most advantage: but as squares of all sizes must be cut from the tables as they are wanted, the average produce per table is not more than 10 ft. superficial.

Labour and putty per foot may be found by multiplying the rate of wages for a glazier per day by the decimal .110.

Example.—To find the value per foot of glazing, with best Newcastle crown glass, or any other kind of glass:—

	£	s.	d.	
Prime cost of crate (12 tables) . .	0	0	0	
Carriage, &c.	0	0	0	
	0	0	0	
20 per cent. profit	0	0	0	
Divide by No. of feet the crate will produce, for best glass . . 120)	0	0	0	
	0	0	0	per foot.
Labour and putty	0	0	0	
Total per foot	£0	0	0	

PAPER-HANGER.

A piece of paper is 12 yards long, and when hung, 20 inches wide. Twelve yards running measure is equal to $6\frac{3}{4}$ square yards, or 60 feet superficial; therefore divide the superficial feet by 5, which will give the number of yards, and these divided by 12 will give the number of pieces of

paper; the price as per agreement, to which price must be added—

For pumicing and preparing the walls, at per piece.
For lining paper, and hanging do. do.
For hanging the paper . . do.
Borders . . . . per doz. yds. run.
Hanging do. . . . . do.

If there be any odd yards they are charged as one piece.

APPENDIX.

ON THE PROPER MODES OF WARMING BUILDINGS.

I HAVE shewn, under the head "Ceilings," that the forms of that member now in use are physically hurtful, and wasteful of life; and I have stated what conditions are necessary to be observed in this part, before we can make a building physically harmless, simply *as a dwelling*, without reference to the carrying on therein any other process than the natural ones of life. Now we want, in our climate, a dwelling that shall not hurt its inmates, either when warmed or when not warmed. It must therefore satisfy the above conditions, just as much as in a climate where no warming is needed;—it must allow nature her course in summer; and then, if the mode of warming used in winter be such as to interrupt or defeat the ventilative process provided for by this construction, such construction must be re-adapted to this artificial state of things by some moveable gear, to be restored to its former state as soon as warming is discontinued. We have next, then, to inquire in what modes of warming this is necessary, and how it is to be done.

Wherever a fire is supplied with air from the room it warms, the external wall outlets above the ceiling (described as necessary to sanitation in a simple unwarmed place) will be, as long as the fire burns, inadmissible. For, supposing them open, the fire would infallibly draw air through them, and down through the ceiling-vents, defeating their whole intention. Yet we have seen the respired breath *cannot* be kept separate, or prevented from fouling the whole air of the room, unless allowed an immediate egress by the way it first seeks, viz. through the ceiling, and thence to the open air. How then is this to be allowed it? With a fire *supplied from the room*, it can be done only in one way, and that far from a good way. Such a fire necessitates a distinct chimney of its own, and this chimney is the *only* outlet by which the foul air above the ceiling can possibly escape. *Any* other opening would become an inlet, and drive it back into the room to feed the fire (which it cannot do without feeding the inhabitants too). As the chimney, then, *must* be its outlet in winter, there is no reason why it should not continue so in summer, and save us the necessity for other outlets, which would have to be stopped in winter by moveable gear. Where our ordinary open fire then is used, there must be openings into the chimney from above the ceiling,—openings of considerable size (for they must, at least, equal in area the whole of the ceiling vents); and this will render them hardly safe against occasional out-draughts from the chimney, which

might bring sparks. Therefore, if the joists and flooring be combustible, such out-draughts must be guarded against by valves opening toward the chimney, but opening as easily as possible; such as may be made by hanging bits of copper-leaf on each separate mesh of a piece of wire netting. But to avoid all needless obstruction, this valve-work should be removed in summer; and, with the incombustible flooring I have described, it will not be wanted at all. Where it is used, access must be given for inspecting, removing, and replacing it, by leaving two or three of the ceiling-pots, next the chimney, loose and uncemented.

It must not be supposed this merely resembles Dr. Arnott's chimney-valves, and may be replaced by that expedient, *below* the ceiling. By no manner of means. This one difference, whether the valve be *above* a *right* ceiling, or *below* a *wrong* one, makes all the difference between a harmless and a life-curtailing dwelling. For a right ceiling will act as a kind of trap to let all rising foul air freely through, and then prevent its return; whereas our noxious ceiling arrests, retains, cools, and sends it down to us again, for the most part long before it can accumulate deep enough to reach and underflow the top edge of the Doctor's aperture. Doctor Arnott was obliged, like other Doctors, to take our work as he found it,—to regard whatever mischief we architects make as a *fait accompli*, which he did his best towards mending; (or nearly his best, for the top margin of his valve should not have hung

down, but the edge have been, at least, *level with* the ceiling: it is a drain; and we might just as well make the entrance of a drain for water open *a little above* the surface to be drained, as make this drain for light air open *a little below* the ceiling). But observe, that the Doctor himself only proposed this expedient — this aftershift (for such it must always be, however improved)—as one that would afford "considerable relief;"—relief against what? against a natural evil? No, against a purely artificial one, created by sham architecture. This is what I want to impress on the reader, to be remembered in presence of all new buildings he may see, or be concerned with:—that the whole of these shifts,—window-opening, draught-seeking, relays of rooms, to use one while another is recovering its freshness, chimney-doctoring, and the whole mystery of ventilation (including Parliamentary air-purveyors, deputy air-purveyors, assistant engineers, sub-assistant engineers, steam-engines, furnaces, shafts, tunnels, towers, mixing-rooms),—all are for partial, *very partial*, relief of *no necessary* evil,—no difficulty of God's ordaining, but purely of *our* the architects' ordaining,—no ill that flesh is heir to, but only one that pedant-ridden ignorance is heir to, and always will be, in spite of it all.

So, to return, of course there must be communication to the above chimney-opening from every part of the ceiling. In the fire-proof construction above described this is met, there being free passage over the tops of the primary bearers, and

through the perforations in the veil or thin part of the joist-bricks, (fig. 22.) So also in our common wooden construction, whenever there are girders, or two sets of joists; but when there is only one set, it will be necessary, in new buildings, to raise the flooring boards an inch or two above them by blocks at intervals. In old ones it might sometimes be easier, when the joists run at right angles to the chimney wall, so that only the trimmer and a few others stop the way, to bore numerous holes in the upper half of each (that being the compressed part) and insert bits of earthen pipe, that will resist compression as well as the wood you have removed, so that the joist will not be weakened.

With regard to more economic and cleanly modes of warming than by our open fire, I believe they must be on a wholly different principle in private buildings from what has been done so successfully in public ones. There are in nature, if not two states or modifications of heat, at least two modes of heating, by contact and by radiation; the latter passing through air (and to some extent transparent bodies) without warming them, but affecting immediately, at a distance, the opaque bodies that absorb it. Now if we are sufficiently warm, it little matters how cold the air be that we breathe; for we may be quite comfortable in bed while breathing air that freezes water in the room. Accordingly, nature's way of warming the world is by radiation, and not by warmed air,—by the sun, and not by the sirocco. This we should imitate as far as we can;

but we cannot at all in *public* buildings; because, the rays from an accessible source being divergent instead of parallel, persons near the source would engross them all, and be scorched, while those at a distance get no benefit. Hence the true modes of warming *these* are heating either the floor (as by Roman and Chinese hypocausts) or the incoming air (as by modern steam and water pipes), both amounting to the same thing, as the fresh air must at its entry first rest on the floor.

In such rooms, then, no fire-place or chimney is necessary or proper; and the provisions for escape of foul air must be precisely as in the simple (*i. e.* the unwarmed or tropical) house. There must be external outlets above the ceiling, on at least two opposite sides; and they must be at least equal in area to double that of all the ceiling vents, because half of them are to be always supposed stopped by the wind. They may slope downward to exclude rain; and should the passage of wind ever make annoying sounds, all the *windward* range of openings may be closed at once, by escocheons connected parallel-ruler-fashion with a long rod, and moved by a cord hanging down through a cornice. But care must be taken that the leeward ones are always open. For carriages the outlets need only be backward; and for cabins they must be tubes running up the ship's side or the masts.

I have spoken of *outlets* first, for they must always be the first considered by the designer before inlets, because the outflow of foul air must precede and *cause* the influx of fresh, and this natural order

of causation cannot possibly be reversed. The only motive power available for ventilation resides in the levity of the foul air, and this *once* opposed is lost, and no other power on earth, impulsive or exhaustive, can supply its place; so that the little ceiling-hole through which it first passes, is the engine that must work the whole ventilation, or nothing else can. Hence the great importance of the least detail about this little engine, to economize to the utmost that delicate prime mover, which is yet sufficient, if economized, to move the whole air of the building, expelling that which has already got above the ceiling, and drawing in from the open air that which the inmates require. The supply of fresh air *must* be drawn in by the foul,—cannot be impelled from behind, and drive the foul before it; for why should it drive out *this* in particular? unless the form of ceiling be such as to let it escape of itself. Thus, no impulsion of fresh air, on "plenum" ventilation, can remedy a wrong form of ceiling; and none can be needed where there is a right one. So that Dr. Ure's fancy for living in a "plenum," or air denser than that without, and having all accidental draughts through chinks outward, instead of inward, however pleasant it may be, has no bearing whatever on purity of air, and can neither aid nor obstruct the natural ventilative process, which will go on, or not, according as the ceiling is rightly or wrongly formed, just the same as if there were no steam-engine and no plenum; all this being no sanitary matter, but a pure

luxury, and one far too costly for more than a *very* few ever to enjoy. In *natural* ventilation, the only sort that mankind in general can ever have, the air of our buildings must be transmitting, not a push but a pull,—from the outgoing air that pulls, to the incoming air that is pulled in; and therefore the internal air *must* be (though to an almost infinitesimal amount) *rarer* than the external, however anxious Dr. Ure may be to make it denser.

As to the inlets, then,—having elsewhere stated how much area to allow them,—we need only add, that their best places are in the risers of steps and seats, if any,—otherwise in the floor. We have thus, then, an arrangement in which ventilation will go on just the same, whether the place be warmed or not; for a public place can only be warmed effectually by warming either the *floor* or *incoming air*. The former mode suits only the ancient fire-proof modes of constructing floors; and the incoming air can only be warmed by contact with surfaces behind which a hot fluid is travelling. The fluid ordained for this purpose is *water*, because, of all known bodies, this contains, at a given temperature, a given quantity of heating power in the least space; and will therefore produce a given effect with less *enclosing material* than steam, air, or any other fluid; and the expenditure of fuel will be the same with all fluids, if properly economized.

So far, then, for public buildings: but the case of domestic ones is widely different, and far from so simple. The very *equality* of warmth produced

by such means has been proved unhealthy. Equality is not nature's law, in heat or anything else. It is *not* desirable that halls and corridors should be as warm as sitting-rooms; but better for the inmates that they should "run across them shivering;" and in rooms, too, the variety of temperature according to distance from a radiating source is proper. To imitate nature, we should contrive as much as possible of the heat generated to be diffused by *radiation;* and when we have got in this way as much as we can (which can never be much, never perhaps a quarter of the whole), then economize the rest, by retaining the products of combustion, in close flues (under the floor, if possible), till we have got from them all the heat not required to carry them well away by levity. Hence the vast superiority of *downward draught* fires, such as Franklin's vase stove,* which, besides being the only ones that really consume their smoke (a duty to our neighbour, as well as a point of economy,) give us also the company of the heated products so much longer, during their descent and re-ascent,—nay, if we had incombustible floors, during a detour under them, or even a journey all across them to a chimney on the opposite side of the room. But the first point I mentioned, preference of *radiated* to *conducted* heat, has never been attended to. For this purpose we should avoid surrounding the fire

* See Tomlinson's "Rudimentary Treatise on Warming and Ventilation," which contains a condensed *resumé* of nearly all that has been done or proposed new in these matters.

with the great solid masses usually found, and rather keep it in a thin metal pot, isolated as much as possible by badly conducting supports reduced to a minimum mass. Thus, by preventing all needless conduction, the more heat would be left to be radiated, and that too from a body of higher temperature,—an advantage, because, to imitate nature, the radiant source *cannot be too hot*, or its rays too nearly approaching in character those of the sun. Again, this temperature might be further augmented by making the fire-pot externally a slower radiator, by gilding, platinating, or coating it with burnished nickel;—not, observe, that less would be radiated by this means, but a higher temperature acquired before establishing equilibrium between the production and expenditure. Now, if by these precautions the whole receptacle were brought to a luminous heat, many or most of its rays would become able to permeate a small thickness of *flint glass* (as they do air) without heating it; and so the whole might be enclosed in a polyhedral glass case, a great advantage, as preventing the hot surfaces either scorching or disturbing with currents the air of the room. But this could not, I fear, be done, either with a common fire, as Dr. M'Cormac proposes, or with any but *flint* glass, the other kinds of glass being greedily absorbent of the dark rays, which form the main portion of all fire-heat. Observe, that all heat absorbed by the glass will not only endanger its cracking, but be lost to us, by heating the next adjacent air, and sending it up

to the ceiling and away unrespired. Hence another reason for getting the utmost practicable temperature in the fire-pot, since (beyond a certain point) the hotter the source, the cooler will the glass remain; a remarkable fact, arising from its having the power of absorbing only the darker rays, and transmitting the brighter without being warmed by them. Again, the mere presence of the glass will enable us to augment the heat of the fire-pot still more, by isolating it on slender legs, allowing us the view and radiation of the flame that descends through the grate. It will also allow the top or mouth to be as wide as we please, for a view of the fuel, which may be heaped above it, instead of being concealed, as in Franklin's vase. Such a stove might require division by a horizontal diaphragm, to stop all downward communication except through the fire; and this diaphragm, to avoid conducting heat from the fire to the glass, should be of earthenware, with inner and outer flanges turning down into grooves containing sand, one on the exterior of the fire-pot, the other on the top of the lower glazed chamber. Its upper surface, that it may reflect, and not absorb, should be gilt and platinated in devices, separated only by narrow white lines; and should have a sand-groove to receive the upper glazed chamber, which may be counterpoised, and lifted bodily for putting on fuel. A supply pipe from its top to the ceiling would enable it to draw all its air from the breath-chamber above, without direct communication with the room.

This leads me to remark that the best relief to be had under our common flat ceilings would be such a supply pipe (either to this glass stove, or to the common Franklin's vase, or indeed any down-draught fire), having its top in the form of a large trumpet-head, as large as the situation of the stove will allow, and oval if standing very near the wall. The lips of this trumpet being brought very near the ceiling (say within a quarter of an inch), would suck in the very extreme layer of foul air, almost as it rises from the inmates, before cooling or much disturbance. And by raising or lowering it through a very small space, the fire might be regulated, or extinguished at once, by thrusting the trumpet-lips up to the ceiling.

Dr. M'Cormac has a plan for feeding the fire with the foul air, retaining both the common impermeable ceiling and common fire-place (glazed in front); but if the foul air be brought down below the level of the fire before re-ascending, it is far better, for economy of heat, that it be burnt on its way *down*, than on its way *up again*, independently of the advantage of consuming smoke.

Of course all these expedients can have no ventilative effect but in winter.

In building expressly for down-draught fires (of any sort), the fire-recesses must be left open to the ceiling, and their flue placed wholly on one side, with a little door into it, four or five feet from the floor, for establishing a draught with burning paper

before lighting the fire.* A glass down-draught stove, as above described, in the *centre* of a room, would be a great luxury, but unattainable without incombustible flooring. Our present flooring obliges it to stand close to the chimney, and most of the heat to be wasted for want of a hypocaust flue. In this case the hinder half of the glazing should be suppressed, and replaced by a concave reflector of iron plated with nickel, of a radius twice or thrice that of the stove itself,—at once admitting it to stand nearer the wall, and throwing over the room those rays that would only have heated the wall behind.

Of course, in all down-draught fires, as the chimney forms an inverted syphon, its effective height (or that on which its draught depends) will be mea-

* All between this door and the fire-grate must be strictly air-tight, which is easily effected by making the lower glass chamber stand in a groove of the base or plinth, containing sand. Instead of a drawer for the ashes, a simple tray, to be lifted out by a central handle, is sufficient. With these precautions, it will doubtless still be found that down-draught fires require what is called "a chimney with a good draught," *i. e.* one happening, from favourable circumstances, to serve, in some measure, like a real chimney (I mean one really designed for its ends). Hence, should down-draught fires ever become general (which they *must*, if the smoke nuisance is ever to be stopped), a return to real chimney-tops will be absolutely imperative. Chimneys *must* again, as formerly, be really organized contrived members of the architects' work. They *must* end each in a distinct detached round shaft of sufficient height, with lily tops, provisions for upward wind-draughts, &c., as practised still, I believe, in Lombardy, the land of their invention. I see no escape from this. "Architectural difficulty" or not, it *must* be met, by architects or somebody; for the barbarous experiments and costly abortions of the chimney-doctors will no longer serve.

sured, not from the fire, but from the level at which air is drawn in to feed it, or in these cases from the ceiling of the room, up to the chimney top; so that about six feet more height will be required to give any chimney the same drawing power that it now has with a common fire.

For places where gas is distributed, Mr. Edwards's 'atmopyre' would doubtless be a noble refinement, if he could but learn to make it shew as a real gas-stove, instead of a sham coal-stove. For this purpose, we might give it downward draught, and the burners might take the form of a cluster of bell-flowers, and be enclosed in a complete globular polyhedron frame of brass, with thin panes of flint glass or talc, one of which, made to open, would suffice for lighting it. The air-supply pipe should come straight down from the ceiling, and the products be carried down through the pedestal, the gas-pipe coming either from above or below. A metal hypocaust flue might enable it to stand safely in the centre of a common wooden floor; but when next a wall, the back half of the polyhedron must be replaced by a reflector, as above described.

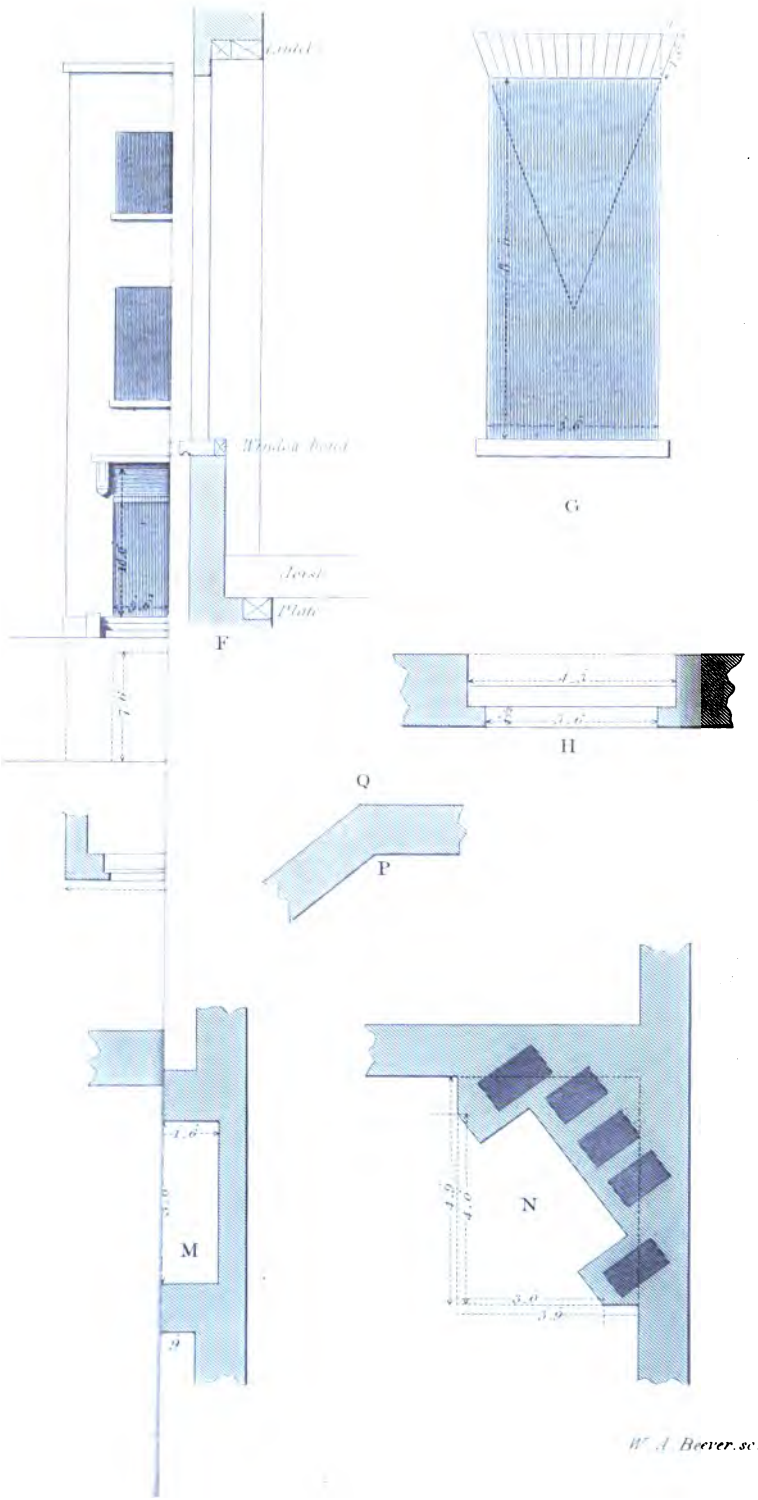
Stove contrivers, by the bye, appear not yet to be aware that *radiant* heat (unlike hot air) travels alike in all directions, so that the level at which a radiant fire will warm persons most equably, is at half their height.

I have entered into these details to shew that no degree of economy in fire-heat need anywise interfere with that PHYSICAL HARMLESSNESS which I

have ventured to set forth as an aim worthy of consideration in architecture; but that it is possible to construct not only shelters, but the most improved shelters, with every comfort and luxury that can honestly be required, and yet not noxious to life; that the natures of the elements and of man have been so adjusted, that a man may, by moderate attention, not to the most refined science, but to the simplest physical laws known in his age, build for all the lawful purposes of that same age, and with all that is convenient, noble or beautiful for a building, yet without hurting its inmates.

THE END.

Printed by C. F. Hogdson, 1 Gough Square, Fleet Street.


Lintel
Window board
Joist
Plate
F
G
H
Q
P
M
N
W. A. Beever. sc.

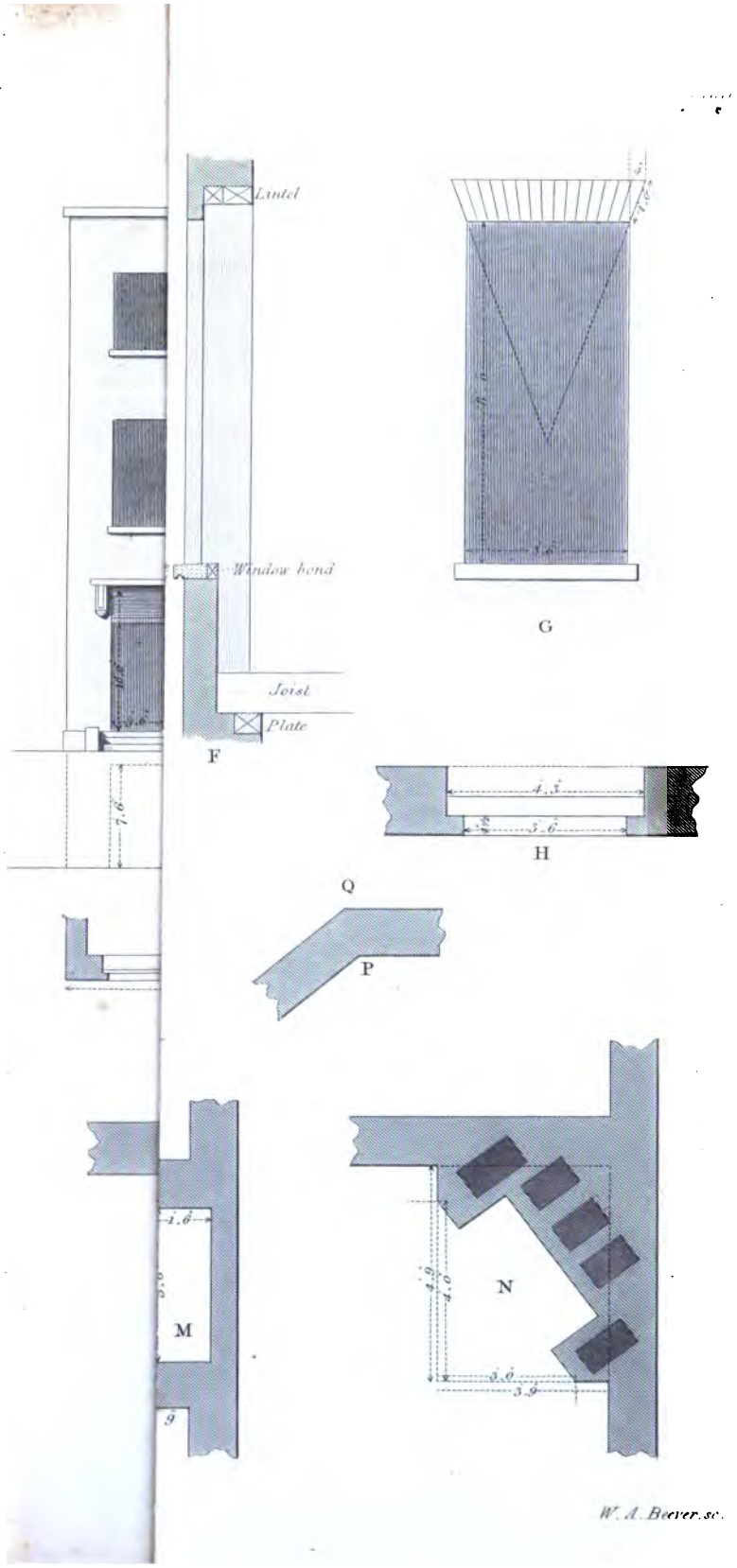
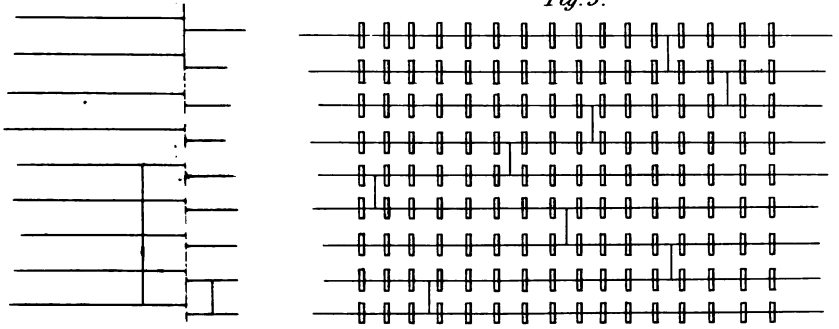
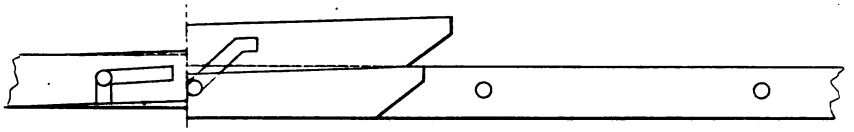

Lintel
Window bond
Joist
Plate
F
G
H
Q
P
M
N
W. A. Beever. sc.

Plate. 2.

Fig. 3.



Dowelled



without disturbing the Dowels.

Floor.

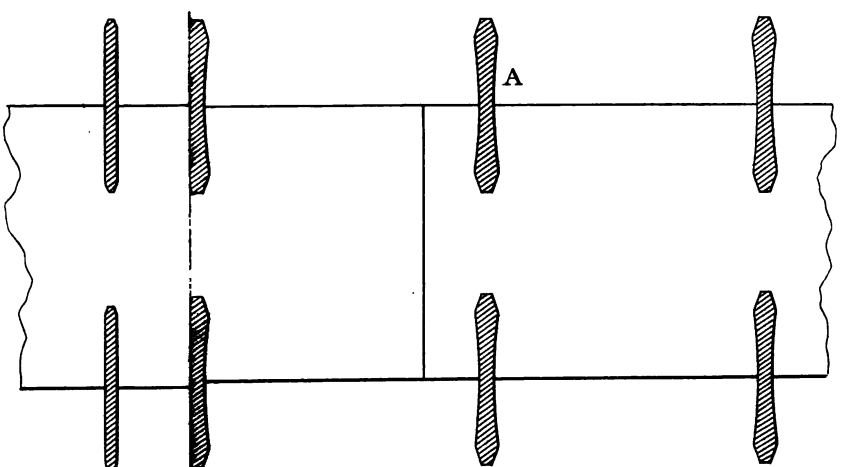
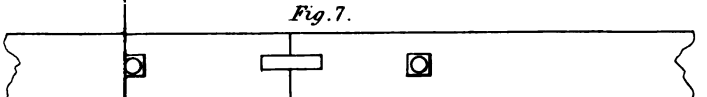


Fig. 7.



Plowed and Tongued heading

W. A. Beever sc

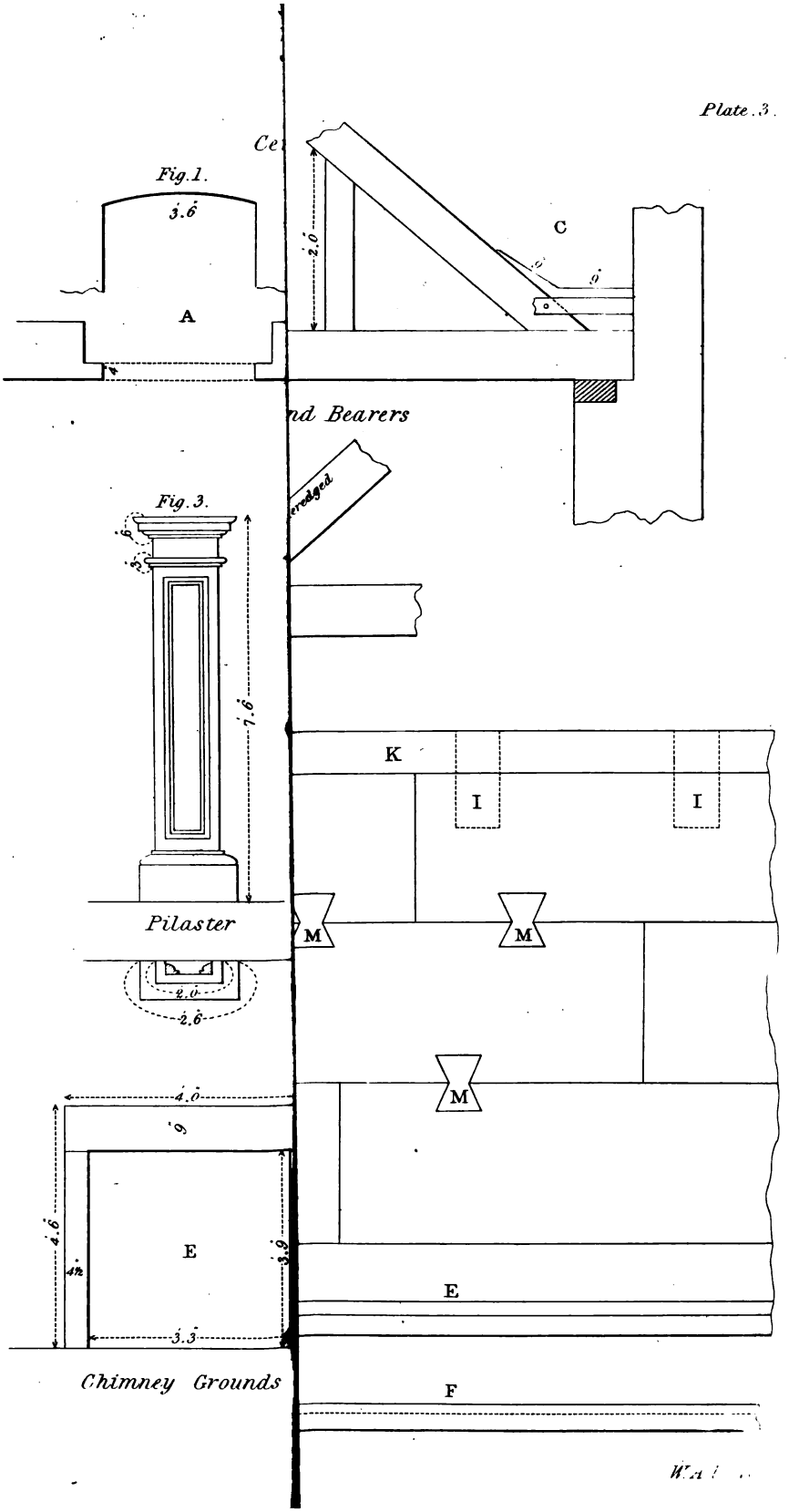


Fig. 1.
3.6
A
2.0
C
9
nd Bearers
Fig. 3.
7.6
Pilaster
2.0
2.6
K
I
I
M
M
M
4.0
9
4.6
E
3.9
4½
3.3
E
Chimney Grounds
F

Sashes and Frames, Shutters &c.

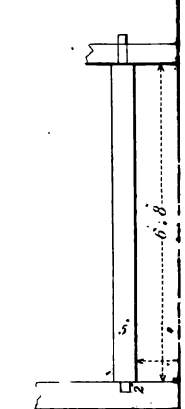
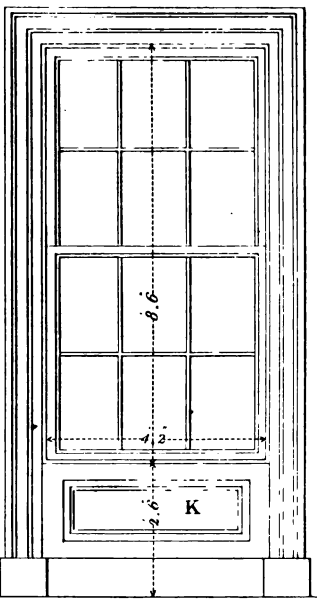


Fig. 7.



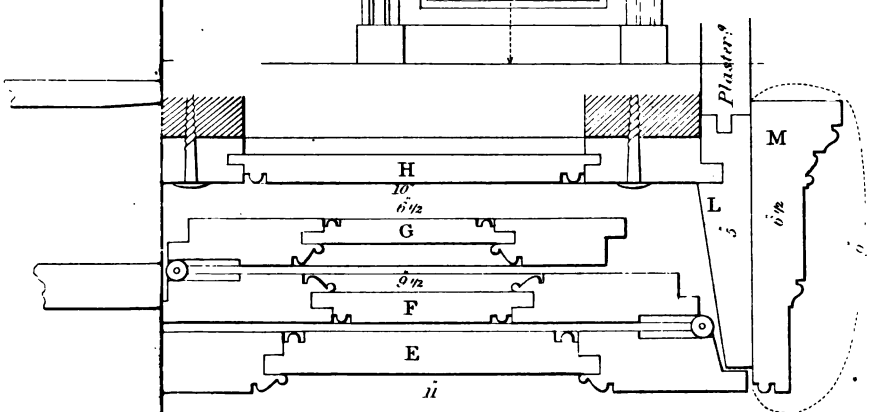


Fig. 8.

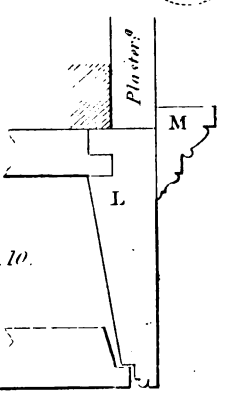
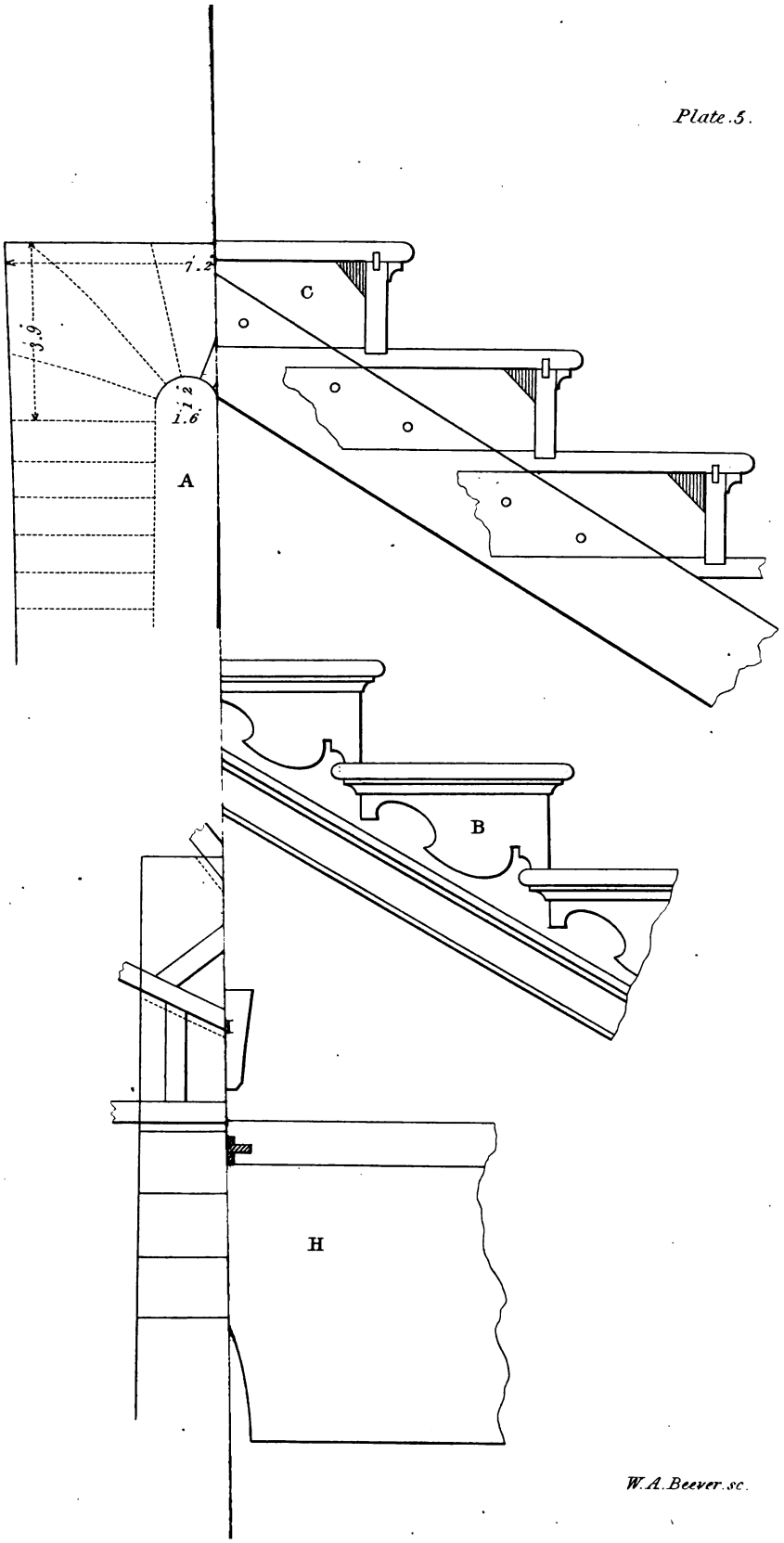
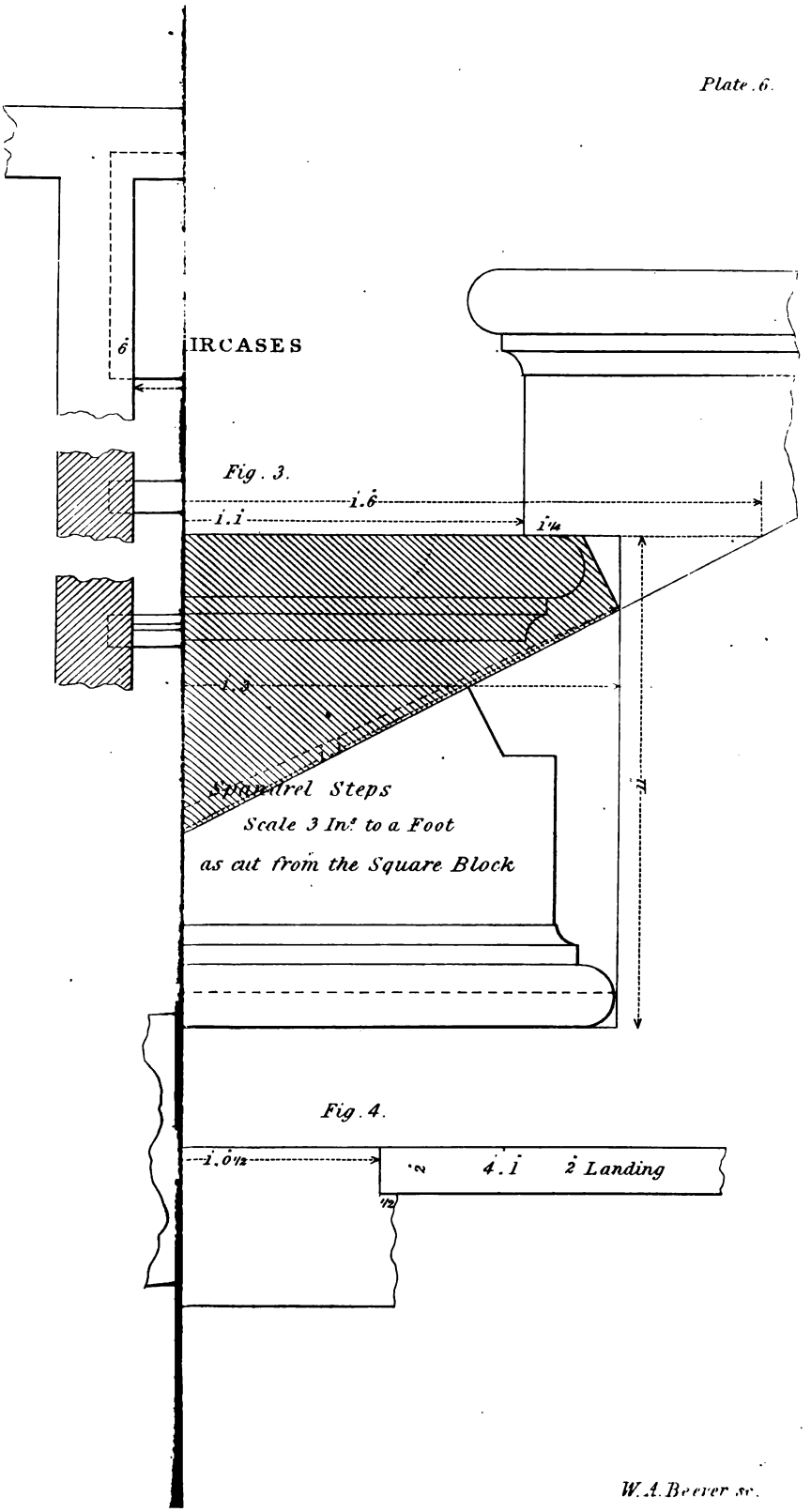


Fig. 10.

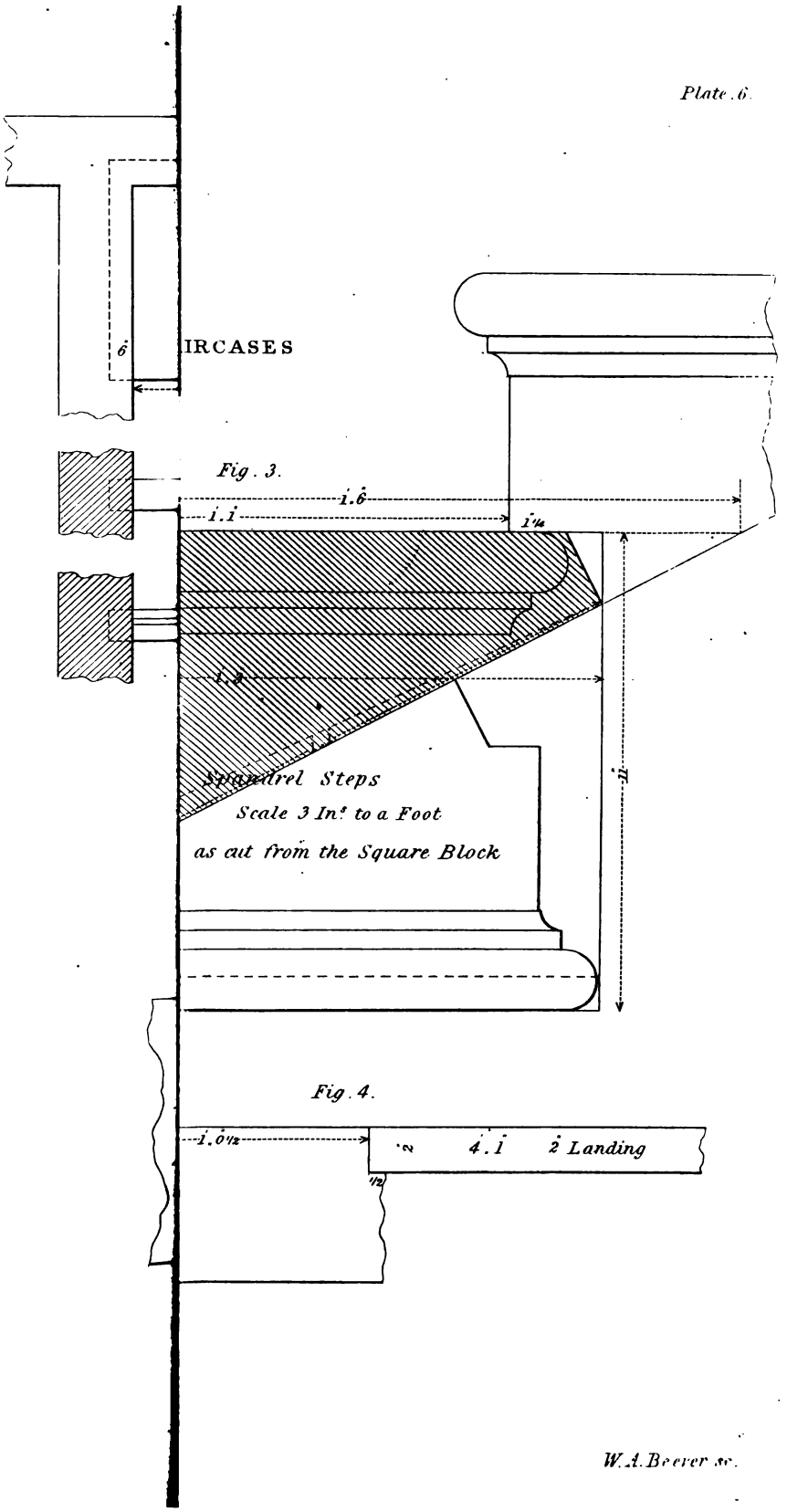
Plate.5.



W.A.Beever.sc.


6
IRCASES
Fig. 3.
1.6
1.1
1'4
1.3
Spandrel Steps
Scale 3 Ins. to a Foot
as cut from the Square Block
Fig. 4.
1.0½
4.1
2 Landing
½

W.A. Beever sc.


6
IRCASES
Fig. 3.
1.6
1.1
1"4
1.8
12
Spandrel Steps
Scale 3 Ins to a Foot
as cut from the Square Block
Fig. 4.
1.0½
4.1
2 Landing
½

W.A. Beerer sc.

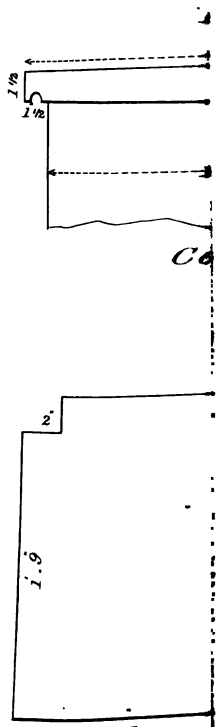
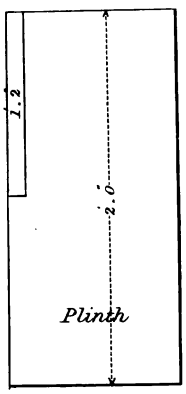


Fig. 9.



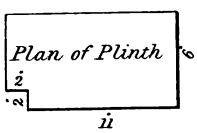
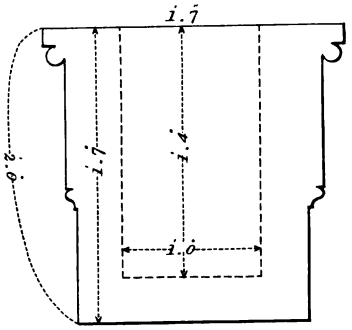
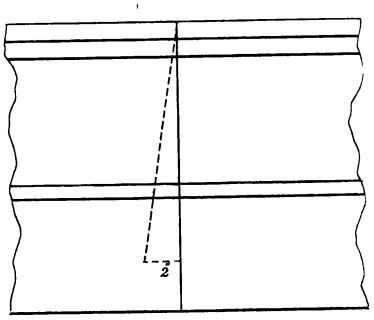


Fig. 10.

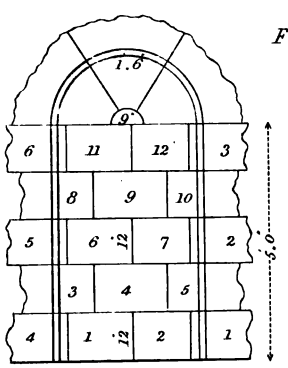


Section of Architrave

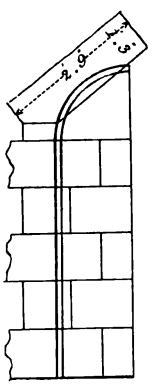


Elevation of Architrave

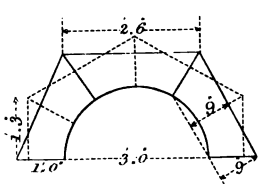
Fig. 11.



Elevation

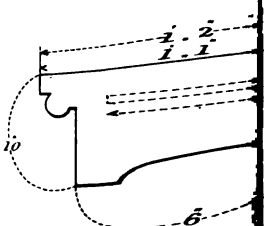


Section



NICHES

Fig.



Bl

W.A.Beever.sc.

Fig. 1.

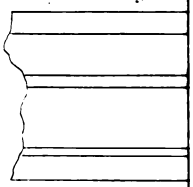


Fig. 2.

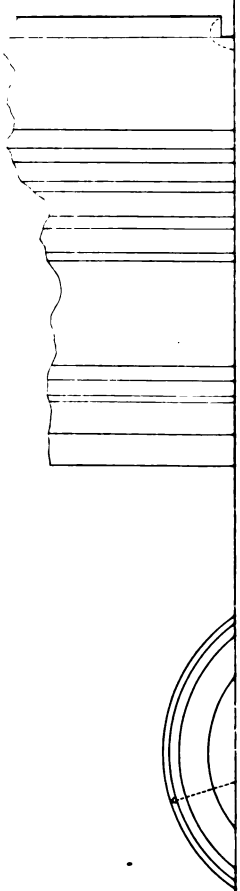
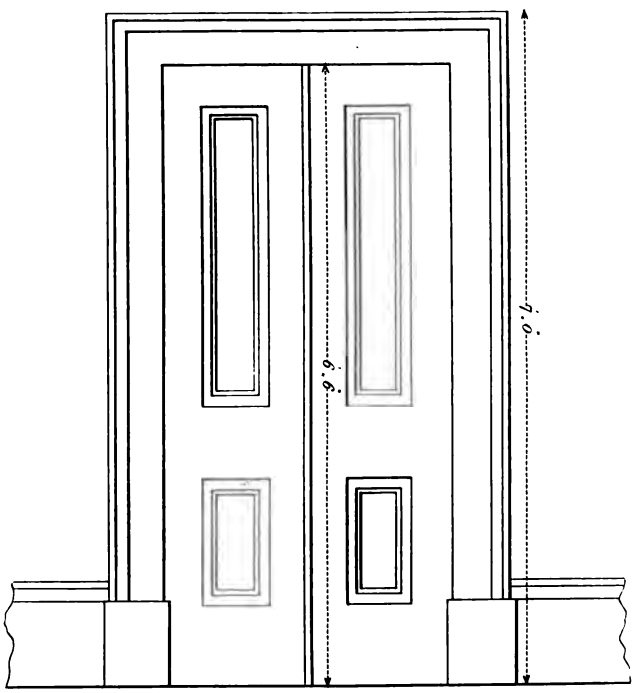
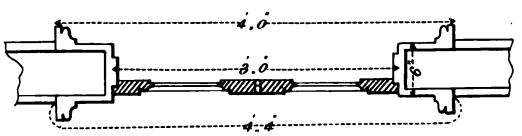
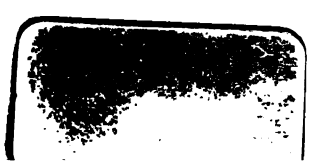


Fig. 5.





W. A. Bell